State of Connecticut

PUBLIC DOCUMENT No. 24

Forty-eighth Report

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

FOR THE YEAR

1924

PRINTED IN COMPLIANCE WITH STATUTE

NEW HAVEN
PUBLISHED BY THE STATE
1925

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

As of October, 1924.

BOARD OF CONTROL.

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W. L. Slate, Jr., *Director and Treasurer* . . . . New Haven
Joseph W. Alsop . . . . Avon
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Biochemical Laboratory.	T. B. Osborne, Ph.D., Sc.D., *Chemist in Charge.*
Botany.	G. P. Clinton, Sc.D., *Botanist in Charge.* E. M. Stoddard, B.S., *Pomologist.* Miss Florence A. McCormick, Ph.D., *Pathologist.* Willis R. Hunt, M.S., *Graduate Assistant.* G. E. Graham, *General Assistant.* Mrs. W. W. Kelsey, *Secretary.*
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Forestry.	Walter O. Filley, *Forester in Charge.* A. E. Moss, M.F., *Assistant Forester.* H. W. Hicock, M.F., *Assistant Forester.* Miss Pauline A. Merchant, *Stenographer.*
Plant Breeding.	Donald F. Jones, S.D., *Geneticist in Charge.* P. C. Mangelsdorf, M.S., *Graduate Assistant.*
Soil Research.	M. F. Morgan, M.S., *Investigator*
Tobacco Sub-station at Windsor.	N. T. Nelson, Ph.D., *Plant Physiologist.*

Publication
approved by
the Board of Control

Press of
The Wilson H. Lee Company
New Haven, Conn.

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Report of the Board of Control

OF

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

To His Excellency, Charles A. Templeton, Governor of Connecticut:

A detailed report of the work of the year will be found in the Report of the Director (Bulletin 264) which is submitted herewith. There are also submitted nine bulletins by various members of the staff dealing in detail with the investigations and other work accomplished.

The Tobacco Station at Windsor has continued the experiments begun in 1922 and has devoted much time to personal service among growers. The fertilizer trials have now run three years and results for that period are reported in Tobacco Station Bulletin No. 5, submitted as a part of this report.

The Station suffered a very great loss in the death of Judge James H Webb, for many years a member of this Board. At its meeting on May 24, 1924, the Board of Control adopted the following minute:

"Judge James H Webb died on April 19, 1924. For thirty years Judge Webb has been a member of this Board, following his father, who was a member from the establishment of this Station in 1877 till his death in 1884.

Judge Webb was a graduate of the Massachusetts Agricultural College, with experience in the management of a dairy farm, a student of law, a teacher in the Yale Law School, a successful attorney and a judge of the Superior Court.

This Board desires to record its tribute to the very valuable services of Judge Webb to this Station, continued freely for so many years, and its very deep appreciation of them.

Practical acquaintance with the problems of the farm, business experience and knowledge of the law made him an adviser of unusual value to the institution. With their appreciation of his services on this Board, its members cannot refrain from expressing their deep sorrow at the loss of a valued personal associate and friend."

Respectfully submitted,

George A. Hopson,

Secretary.

Report of the Treasurer

July 1, 1923—July 30, 1924

W. L. Slate, Jr., in account with The Connecticut Agricultural Experiment Station for the fiscal year ended June 30, 1924.

Receipts.

Balance on hand, July 1, 1923, Miscellaneous Receipts			$226.08
State Appropriation (General or Current Expense)		$50,000.00	
" " (General) (Additions)		599.16	
" " (Food and Drug)		7,500.00	
" " (Insect Pest)		15,000.00	
" " (Insect Pest) (Additions)		759.18	
United States Appropriation (Hatch)		7,500.00	
" " " (Adams)		7,500.00	
Fertilizer Analysis Fees		11,000.00	
Lockwood Trust Fund (including sales of Mount Carmel Farm Produce)		8,000.00	
		$107,858.34	
Miscellaneous Receipts:			
Connecticut State Department of Health (rent)	$200.00		
Sales of gasoline	242.30		
Sales of automobile oil	7.68		
Mileage for use of automobiles	168.80		
Court fees	6.07		
Miscellaneous	48.80		
Interest on bank deposits	192.13		
		865.78	
			108,724.12
			$108,950.20
Less Miscellaneous Receipts Deposited with State Treasurer			817.05
			$108,133.15

DISBURSEMENTS.

Salaries	$57,314.76	
Labor	10,506.30	
Stationery and Office Supplies	623.24	
Scientific Supplies (chemicals)	829.13	
" " (other laboratory)	270.19	
" " (photographic)	120.22	
Feeding Stuffs	18.00	
Insecticides, Fungicides, etc.	282.98	
Lumber and Small Hardware	124.92	
Miscellaneous Supplies	1,080.99	
Automobile Oil	122.77	
Food Samples	41.90	
Fertilizers	694.05	
Telegraph and Telephone	310.35	
Postage	386.22	
Travel (outlying investigations)	1,537.40	
" (meetings, etc.)	814.54	
" (gasoline for automobiles)	812.44	
Freight, Express and Parcels Post	197.32	
Publications (bulletins, etc.)	60.63	
" (miscellaneous)	134.82	
Coal	2,072.95	
Gas and Electricity	1,684.11	
Water	209.95	
Furniture and Fixtures (new)	443.19	
" " " (repairs)	233.15	
Library (books and periodicals)	724.14	
" (binding)	427.15	
Scientific Equipment (new)	175.73	
" " (repairs)	20.20	
Automobiles (new)	480.25	
" (repairs)	469.08	
Tools, Machinery and Appliances (new)	220.01	
" " " " (repairs)	115.02	
New Buildings and Structures	204.13	
Buildings (repairs and alterations)	716.22	
Insurance (fire, burglary and automobile)	1,443.80	
Taxes	203.99	
Insect Pest Appropriation to State Entomologist	15,759.18	
Miscellaneous Contingent Expenses	77.75	
Total Disbursements		$101,963.16
Balance on hand, June 30, 1924:		
State General Appropriation	$5,895.18	
Miscellaneous Receipts	274.81	
		6,169.99
		$108,133.15

NEW HAVEN, CONN., Aug. 1, 1924.

This is to certify that we have examined the accounts of W. L. Slate, Jr., Treasurer of The Conn. Agr. Experiment Station for the fiscal year ending June 30, 1924, and have found them correct.

WILLIAM P. BAILEY,
LEWIS W. PHELPS,
Auditors of Public Accounts.

REPORT OF

W. L. SLATE, Jr., Director

IN ACCOUNT WITH

Mosquito Elimination Appropriation

For the Fiscal Year Ending June 30, 1924

RECEIPTS.

Balance on hand, July 1, 1923 (Petty Cash Fund)	$500.00	
State Appropriation	6,000.00	
Additions to Appropriation (contributions and collections from towns)	2,210.63	
Total		$8,710.63

EXPENDITURES.

By the State Comptroller on vouchers submitted by W. L. Slate, Jr., Director:		
Salaries	$1,833.34	
Labor	5,359.74	
Supplies	556.47	
Miscellaneous Supplies	68.64	
Travel	392.44	
	$8,210.63	
Balance on hand July 1, 1924 (Petty Cash)	500.00	
		$8,710.63

REPORT OF

W. L. SLATE, Jr., Director

UNDER THE

Tobacco Research Act

(Public Acts, 1921, Chap. 184)

For the Fiscal Year Ending June 30, 1924

RECEIPTS.

State Appropriation	$10,000.00	
Additions to Appropriation	379.53	
Total		$10,379.53

EXPENDITURES.

By the State Comptroller on vouchers submitted by W. L. Slate, Jr., Director:		
Salaries	$600.00	
Labor	4,251.25	
Publications	80.70	
Stationery	76.49	
Telephone and Telegraph	13.82	
Team and Horse Hire	205.32	
Water	5.00	
Tools, Machinery and Appliances (new)	15.00	
Traveling Expenses	198.15	
Insurance	490.00	
Buildings (new)	4,343.80	
Buildings (repairs)	100.00	
		$10,379.53

BULLETIN 261 NOVEMBER, 1924

Connecticut Agricultural Experiment Station

New Haven, Connecticut

Fertilizer Report for 1924

E. M. BAILEY, *Chemist in Charge of the Analytical Laboratory.*

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The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

November, 1924.

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Elijah Rogers .... Southington
Edward C. Schneider .... Middletown
Francis F. Lincoln .... Cheshire

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Soil Research.	M. F. Morgan, M.S., *Investigator.*
Tobacco Sub-station at Windsor	N. T. Nelson, Ph.D., *Plant Physiologist.*

Report on Commercial Fertilizers, 1924.

E. M. BAILEY, *Chemist in Charge, Analytical Laboratory.*

THE FERTILIZER LAW.

The provisions of the fertilizer law have been discussed in previous reports but for more ready reference the essential features may be repeated.

SIGNIFICANCE OF THE TERM "COMMERCIAL FERTILIZERS"

Explaining what is meant by the term "commercial fertilizers" the law says:

"The term 'commercial fertilizers' shall be construed to mean any and every substance imported, manufactured, prepared or sold for fertilizing or manuring or soil amendment purposes, except barnyard manure and stable manure which have not been artificially treated or manipulated, marl and lime. Cottonseed meal, rapeseed meal, castor pomace and all other vegetable products used as fertilizers, including the ashes of cotton hulls and wood ashes, shall be included as fertilizers within the meaning of this act and separate analysis fees shall be paid on each different grade which is sold or offered for sale in the state. The person responsible for paying the fees above prescribed may deduct from the total tonnage sold such sales of cottonseed meal or other vegetable products as are made to anyone who gives a written certificate on a form supplied by the Connecticut Agricultural Experiment Station stating that the material bought by him was to be used exclusively for feed and not for fertilizer."

CONCERNING COTTONSEED MEAL.

Cottonseed meal is a fertilizer within the meaning of the Statute but it is provided that when this product is sold for feeding purposes only, it shall be exempt from the tonnage tax.

The status of cottonseed meal under the fertilizer law has been clearly stated in a bulletin[1] from this Station from which the following may be quoted:

Registration and analysis fees. "Each brand of cottonseed meal must be registered on forms provided by this Station and an analysis fee of ten dollars paid on it before it is sold, offered or exposed for sale, and on the *first day of January annually thereafter.*

"A distinctive name constitutes a distinct brand. If shipments have different guaranties of composition they are held to be different brands."

Branding or tagging. "Since nitrogen is the only fertilizer ingredient considered in the trade in cottonseed meal no guaranty of phosphoric acid or potash is required. If either is guaranteed by the manufacturer, however, an additional fee of ten dollars must be paid on each element. The statement of composition now legal for feeds may be used hereafter if the percentage of nitrogen is stated.

[1] Bull. of Information No. 9, 1919.

"Note that the law regarding feeding stuffs forbids the use of metal in attaching tags and requires that each package shall be branded or tagged with the statement required by law."

Duties of shippers. "It is assumed from correspondence with shippers outside the state that they will register the brands which they sell in Connecticut, will pay analysis fees as has been done in the past by manufacturers of commercial fertilizers, and will semi-annually thereafter pay the tonnage fees.

"They will report to this Station their total sales and, if they wish, may report what part has been sold for feed exclusively. From the reports of dealers within the state it will be possible to determine quite closely the amounts of each brand actually used as feed.

"In the case the jobber outside the state neglects or refuses to register a brand, the dealer who sells it within the state is responsible under the law."

Duties of dealers. "Dealers are required to file with the director of the Station on July first of each year and semi-annually thereafter a sworn statement of their total sales of each brand of cottonseed meal and the amount of each sold exclusively for feed, during the preceding six months."

Requirements to be Complied with by Sellers of Commercial Fertilizers.

The seller is responsible for the proper labeling of each package, for the registration at the Station of every brand sold by him and for the payment of the analysis fee, before offering for sale, and annually thereafter on January 1st.

The law specifies the information which shall be given on the label as follows:

1. *Weight of each package in pounds.*
2. *Brand name or trade mark.*
3. *Analysis:*
    - (a) *Available phosphoric acid, per cent.*
    - (*b*) *Total phosphoric acid, per cent.*
    - (*c*) *Nitrogen, per cent.*
    - (*d*) *Equivalent ammonia, per cent.*
    - (*e*) *Potash soluble in water, per cent.*
4. *Name and address of the manufacturer or of the person who is responsible for the statements of the guaranty.*

In the case of bone meal, tankage or other organic products, and in basic slag and mineral phosphates in which a large percentage of the phosphoric acid is not available by laboratory methods, the phosphoric acid shall be claimed as total phosphoric acid unless it is desired to claim available phosphoric acid instead, in which case the guaranty shall take the form set forth above.

The label may be a tag attached to the package or a statement printed thereon. Percentages shall be minimum percentages only.

The presence of leather in its various forms, wool waste, hair or any inert nitrogenous material shall be declared on the label unless, by processing, the activity of these materials has been rendered satisfactory as determined by official methods.

When potash is derived from sulphate or carbonate of potash it may be so claimed.

No claim or guaranty for less than 0.82 per cent of nitrogen, or for less than 1 per cent of phosphoric acid, or for less than 1 per cent of potash shall be regarded in the registration or analysis of any commercial fertilizer.

The seller must also, on the 1st of January and July, report the tonnage of fertilizer sold within the preceding six months and pay to the director of the Station a tonnage fee of 6 cents per ton.

On request, copies of the law and blanks for registration and for tonnage reports will be supplied by the Station.

If, however, proper labeling, registration and payments have been provided for by the manufacturer of the brands or by another responsible person, all sellers of such brands are released from the above mentioned requirements. The retailer, therefore, should assure himself that the requirements of the law have been met by the manufacturers of the brands which he handles, or himself be prepared to meet all these requirements.

Precautions to be Observed in Drawing Samples for Analysis.

The analysis of a fertilizer is of no value unless the sample analyzed represents as nearly as possible the stock from which the sample was drawn. The law prescribes the procedure to be followed by authorized agents of this Station when taking official samples for analysis as follows:

"When samples are taken from fertilizers in bags, a tube shall be used, and it shall be inserted at one end of the bag and shall pass substantially the entire length of the bag, so as to take a core of the material being sampled from substantially the entire length of the bag. Samples thus taken from individual bags shall be thoroughly mixed, and the official samples shall be taken from the mixture so drawn by the method known as 'quartering'. Samples of fertilizer taken as herein provided shall be taken from at least five per centum of the separate original unopened packages in the lot, for the mixture from which the official samples shall be taken. If less than one hundred bags are in the lot, at least five bags shall be sampled; if less than five bags, all shall be sampled. Broken packages shall not be sampled."

Gratuitous Analyses.

Under the fertilizer law the Station is charged only with the analysis of samples drawn by its own agents. It does, however, each year analyze a considerable number of samples drawn by individuals, representing stock purchased by them for their own use. The object of the purchaser is to satisfy himself as to whether he has obtained goods of the grade represented and, perhaps, to obtain evidence upon which to base a claim for shortage should the materials not meet their guaranties. The Station assumes no responsibility for the sampling in case of such unofficial samples

and can only vouch for the accuracy of the results obtained on the materials as submitted. Since a representative sample is as essential as an accurate analysis in judging the quality of a shipment of fertilizer, it is evident that a satisfactory adjustment will seldom be effected on the basis of an unofficial sample. Notwithstanding certain objections which may be raised to the practice of analyzing samples submitted by individuals, the Station is disposed to continue such work so long as there is evidence that it constitutes a useful service; it cannot, however, undertake for any one individual or group, work in such volume or with such frequency that it becomes a systematic control over current purchases. This clearly invades the field of the commercial laboratory.

REGISTRATIONS.

Late Registrations for 1923.

To the brands registered for 1923 in our last report should be added:

Standard Agricultural Chemical Corporation, 2 Rector Street, New York, N.Y.

Prepared Alphano Humus

Registrations for 1924.

For 1924, 56 individuals and firms registered at this Station for sale in this State 433 brands of fertilizers. As required by Statute the brands so registered are listed as follows:

Aben Hardware Co., 74-78 Bank Street, New London, Conn.

5-10-5 Fertilizer

American Agricultural Chemical Co., 2 Rector Street, New York, N. Y.

Agrico Tobacco Manure
Castor Pomace
Cereal Mixture
Complete Potato Mixture
Corn Favorite
Double A Tobacco Fertilizer
Double Manure Salts
Dry Ground Fish
Fine Ground Bone
Fish and Potash
Five-Four-Three Tobacco Fertilizer
Grass and Lawn Top Dressing
Hercules Top Dresser
High Grade Acid Phosphate
Nitrate of Soda
Pulverized Sheep Manure
7% Potash Fertilizer
Sulphate of Potash
Universal Phosphate

Bradley's Complete Manure for Potatoes and Vegetables
Bradley's Complete Tobacco Manure
Bradley's Corn Phosphate
Bradley's New Method Fertilizer
Bradley's Northland Potato Grower
Bradley's Potato Fertilizer
Bradley's Potato Manure
Bradley's Superior Tobacco Compound
Bradley's XL Superphosphate of Lime
Lister's Complete Tobacco Manure
National Complete Tobacco Fertilizer
National Eureka Potato Fertilizer
National Market Garden Fertilizer
National Potato and Corn Phosphate
National Premier Truck Manure
National Special Tobacco
National White Ash Tobacco Grower
National XXX Fish and Potash
Quinnipiac Corn Manure
Quinnipiac Market Garden Manure
Quinnipiac Potato Phosphate
Quinnipiac Prime Tobacco Manure
Quinnipiac Seed Leaf Tobacco Manure
Wheeler's Corn Fertilizer
Wheeler's Cuban Tobacco Grower
Wheeler's Potato Manure
Wheeler's Universal Mixture
Patapsco 5–8–7 Fertilizer
Patapsco 4–8–7 Fertilizer
Patapsco General Truck Fertilizer
Patapsco Matchless Potash Manure
Patapsco Peerless Potato Guano
Patapsco 16% Acid Phosphate

pothecaries Hall, Co., Waterbury, Conn.

Acid Phosphate
Animal Tankage (9.5–3)
Animal Tankage (7–5)
Bone and Meat Tankage
Bone Meal
Carbonate Potash 62%
Castor Pomace
Double Sulphate Potash and Magnesia 26% K_2O
Fish
Liberty Corn, Fruit and All Crops
Liberty Fish, Bone and Potash
Liberty High Grade Market Gardeners
Liberty High Grade Tobacco Manure
Liberty Market Gardeners Special
Liberty Tobacco Special
Liberty Top Dresser for Grass and Grain
Liberty 2-8-2
Muriate Potash
Nitrate Soda and Potash
Nitrate Soda
Precipitated Bone
Sulphate Potash
Tankage 9-9

Armour Fertilizer Works, 305 Broadway, New York, N. Y.

Armour's Big Crop Acid Phosphate 16%
Armour's Big Crop Fertilizer 8-6-6
Armour's Big Crop Fertilizer 5-8-5
Armour's Big Crop Fertilizer 5-8-7
Armour's Big Crop Fertilizer 4-8-4
Armour's Big Crop Fertilizer 4-6-10
Armour's Big Crop Fertilizer 3-8-4
Armour's Big Crop Fertilizer 2-12-2
Armour's Big Crop Tobacco Special 5-4-5
Armour's Corn Grower 2-8-2
Bone Meal 3-48
Ground Tankage 9-15
Muriate of Potash 48%
Nitrate of Soda 18%
Raw Bone Meal 4.5-47
Sheep Manure 1.5-1-2
Sulphate of Ammonia 25%
Sulphate of Potash 48%

Ashcraft-Wilkinson Company, Trust Co. of Georgia Building, Atlanta, Georgia.

Helmet Brand Prime Cotton Seed Meal
Monarch Brand Prime Cotton Seed Meal
Paramount Brand Prime Cotton Seed Meal

Atlantic Packing Co., New Haven, Conn.

Atlantic 5-8-7
Atlantic 4-8-6
Atlantic Grain Fertilizer 2-8-2
Atlantic Potato Phosphate 3-8-4
Atlantic Special Vegetable 4-8-4
Atlantic Tobacco Grower 5-4-5
Atlantic Tobacco Manure 5-8-6
Atlantic 7-5-4

Baker Castor Oil Company of New Jersey, 120 Broadway, New York, N. Y.

Castor Pomace

Barrett Co., 40 Rector St., New York, N. Y.

Arcadian Sulphate of Ammonia

F. A. Bartlett Tree Expert Co., Stamford, Conn.

Bartlett's Green Tree Food

Berkshire Fertilizer Co., Bridgeport, Conn.

Acid Phosphate
Berkshire Castor Pomace
Berkshire Complete Fertilizer
Berkshire Complete Tobacco
Berkshire Dry Ground Fish
Berkshire Economical Grass Fertilizer
Berkshire Fine Ground Bone
Berkshire Grass Special
Berkshire Long Island Special
Berkshire Market Garden
Berkshire Potato and Vegetable Phosphate

Berkshire Sheep Manure
Berkshire Tobacco Special
Double Manure Salt
Ground Tankage
High Grade Sulphate of Potash
Muriate of Potash
Nitrate of Soda
Precipitated Bone Phosphate
Wool Waste

F. E. Boardman, Middletown, Conn.

Boardman's Complete Fertilizer for Potatoes and General Crops
Boardman's Tobacco Fertilizer.

Bowker Fertilizer Company, 60 Trinity Place, New York, N. Y.

Bowker's All Round Fertilizer
Bowker's Connecticut Valley Tobacco Fertilizer
Bowker's Corn, Grain and Grass Phosphate
Bowker's Fisherman's Brand Fish and Potash
Bowker's Market Garden Fertilizer
Bowker's Potato and Vegetable Phosphate
Bowker's 16% Acid Phosphate
Bowker's Square Brand Farm and Garden Phosphate
Bowker's Sure Crop Phosphate
Stockbridge Early Crop Manure
Stockbridge Potato and Vegetable Manure
Stockbridge Premier Tobacco Grower
Stockbridge Tobacco Manure
Stockbridge Top Dressing and Forcing Manure
Stockbridge Truck Manure

Bridge's Sons, Inc., Amos D., Hazardville, Conn.

Corn, Onion and Potato and General Purpose
Special Tobacco Fertilizer

Buckeye Cotton Oil Company, Cincinnati, Ohio.

"Buckeye" 36% Protein Cottonseed Meal—Good Quality

Chittenden Co., E. D., Bridgeport, Conn.

Chittenden's Acid Phosphate
Chittenden's Castor Pomace
Chittenden's Complete Grain
Chittenden's Dry Ground Fish
Chittenden's Ground Bone
Chittenden's High Grade Tobacco
Chittenden's Nitrate of Soda
Chittenden's Potato Special 4% Potash
Chittenden's Potato Special 6% Potash
Chittenden's Tobacco Special
Chittenden's Top Dresser
Chittenden's Vegetable and Onion Grower
Chittenden's Complete Tobacco and Onion Grower, 4% Potash

Clark Seed Co., Everett B., Milford, Conn.

Acid Phosphate 16%
Clark's Special Mixture for General Use
Clark's Special Mixture with 6% Potash
Clark's Tip Top Brand 5-8-5
Nitrate of Soda

Coe-Mortimer Co., 2 Rector Street, New York, N. Y.

E. Frank Coe's Celebrated Special Potato Fertilizer
E. Frank Coe's Columbian Corn and Potato Fertilizer
E. Frank Coe's Connecticut Wrapper Grower
E. Frank Coe's Gold Brand Excelsior Guano
E. Frank Coe's New Englander Special
E. Frank Coe's Red Brand Excelsior Guano
E. Frank Coe's 16% Superphosphate
E. Frank Coe's Special Grass Top Dressing
E. Frank Coe's *Standard Potato Fertilizer*

Connecticut Fat Rendering & Fertilizing Corporation, West Haven, Conn.

Tankage

Consolidated Rendering Co., 40 North Market Street, Boston (9), Mass.

Acid Phosphate 16%
Ground Bone (2.50-26)
Ground Bone (3.00-24)
Muriate of Potash
Nitrate of Soda
Sulphate of Ammonia
Sulphate of Potash
Tankage 6-30
Tankage 9-20

Cowles, C. A., Plantsville, Conn.

C. A. Cowles 4-8-4 Fertilizer

Davis, S. P., 207 Southern Trust Building, Little Rock, Arkansas.

Beauty Cottonseed Meal
Goodluck Brand Cottonseed Meal and Cracked Screened Cake
Steerboy Brand Cottonseed Meal and Cracked Screened Cake

Eastern States Farmers' Exchange, 33 Lyman Street, Springfield, Mass.

Acid Phosphate 16%
Castor Pomace
Eastern States 4-8-4
Eastern States 6-3-5
Eastern States 6.25-3-5
Eastern States 7-2-7
Eastern States 3-12-3 No-Filler
Eastern States 5-8-7 No-Filler
Eastern States 5-10-5 No-Filler
Eastern States 7-8-3 No-Filler
Eastern States Dry Ground Fish
Eastern States Fine Bone Meal
Eastern States Sulphate of Potash
Ground Animal Tankage
Muriate of Potash
Nitrate of Soda Reground
Sulphate of Ammonia

Essex Fertilizer Company, 39 North Market Street, Boston, Mass.

Essex Fish Fertilizer for All Crops 3-8-4
Essex 5-8-7 for Potatoes and Vegetables
Essex 4-6-10 for Potatoes and Vegetables
Essex Market Garden for Potatoes, Roots and Vegetables 4-8-4
Essex Potato Phosphate 4-8-7 for Potatoes and Vegetables

Essex Special Tobacco 5-4-5
Essex Tobacco Manure 5-8-6
Essex 2-8-3 for All Crops
Essex 2-8-2 for Farm and Garden

Frisbie Co., L. T., New Haven, Conn.

Castor Pomace
Dry Ground Fish
Frisbie's Bone Meal
•Frisbie's Corn and Grain Fertilizer 2-8-2
Frisbie's 5-8-7
Frisbie's Market Garden 4-8-6
Frisbie's Special 4-10-6
Frisbie's Special 3-8-4
Frisbie's Special Vegetable and Potato Grower 4-8-4
Frisbie's Tobacco Grower 5-4-5
Frisbie's Tobacco Manure 5-8-6
Frisbie's Top Dresser 7-5-4

Humphreys-Godwin Co., Inc., Memphis, Tennessee.

Bull Brand Cottonseed Meal
Danish Brand Cottonseed Feed
Dixie Brand Cottonseed Meal

International Agricultural Corporation (Buffalo Fertilizer Works),Boston, Mass.

Buffalo Crop Grower
Buffalo General Favorite
Buffalo High Grade Manure
Buffalo New England Special
Buffalo Phosphate and Potash
Buffalo Sixteen Per cent.
Buffalo Tobacco Producer
Dry Ground Fish
I. A. C. Connecticut Valley Special
International Double Strength 10-8-10

Joynt, John, Lucknow, Ontario, Canada.

The Joynt Brand Canada Unleached Hardwood Ashes

Lovitt & Co., L. B., Memphis, Tennessee.

Lovit Brand Cottonseed Meal 5.75%
Lovit Brand Cottonseed Meal 6.58%
Lovit Brand Cottonseed Meal 6.88%

Lowell Fertilizer Company, 40 North Market St., Boston, Mass.

Lowell Animal Brand, a High Grade Manure for All Crops 3-8-4
Lowell Bone Fertilizer, For Corn, Grain, Grass and Vegetables 2-8-2
Lowell 5-8-7 for Potatoes and Vegetables
Lowell 4-8-4 for Potatoes, Corn and Veg.
Lowell 4-6-10 for Potatoes and Vegetables
Lowell Potato Phosphate for Potatoes and Vegetables 4-8-7
Lowell Tobacco 5-4-5 for Tobacco, Fruits and Vines
Lowell Tobacco Manure 5-8-6
Lowell Top Dressing 7-5-2

Mapes Formula & Peruvian Guano Co., 110 William St., New York, N. Y.

The Mapes Connecticut Valley Special
The Mapes Corn Manure
The Mapes C. S. Tobacco Manure
The Mapes General Tobacco Manure
The Mapes General Truck Manure
The Mapes General Use Manure
The Mapes Grain Brand
The Mapes Onion Manure
The Mapes Potato Manure
The Mapes Tobacco Ash Constituents
The Mapes Tobacco Manure—Wrapper Brand
The Mapes Tobacco Starter Improved
The Mapes Top Dresser

Memphis Cottonseed Products Co., Inc., 1015 Falls Building, Memphis, Tennessee.

Durham Thirty-Six

Mitchell, Walter L., 699 Forest Road, New Haven, Conn.

Mitchell's 5-8-7
Mitchell's Tennessee Phos-Pho-Flour

Natural Guano Company, Aurora, Illinois.

"Sheep's Head" Pulverized Sheep Manure

Neal & Co., Inc., R. N., Memphis, Tennessee.

"Triangle" Brand Prime 36% Protein.
"Triangle" Brand Prime 41% Protein
"Triangle" Brand Prime 43% Protein

New England By-Products Corp., 20 West Street, Lawrence, Mass.

Ground Steamed Bone
Pure Bone Meal

New England Fertilizer Co., 40A North Market Street, Boston, Mass.

Fish
New England Corn Phosphate for Grain and Vegetables 2-8-2
New England 5-8-7 for Potatoes and Market Gardens
New England 4-8-4 for Potatoes, Vegetables and Grass
New England Potato Phosphate 4-8-7 for Potatoes and Vegetables
New England Superphosphate, a High-Grade Fertilizer for all Crops, 3-8-4
New England Tobacco 5-4-5
New England Tobacco Manure 5-8-6
New England 2-8-3 for Vegetables and Grain

Nitrate Agencies Company, Bound Brook, N. J. (104 Pearl St., New York, N. Y.)

Naco Brand 2-8-2
Naco Brand 4-8-4
Naco Brand 4-8-7
Naco Brand 5-8-7
Naco Brand Acid Phosphate
Naco Brand Animal Tankage
Naco Brand Castor Pomace
Naco Brand Fish
Naco Brand Muriate of Potash

Naco Brand Nitrapo
Naco Brand Nitrate of Soda
Naco Brand Peruvian Guano
Naco Brand No. 12 Peruvian Guano Mixture
Naco Brand No. 14 Peruvian Guano Mixture
Naco Brand No. 50 Peruvian Guano Mixture
Naco Brand Equivalent 5-8-7 Genuine Peruvian Guano Mixture
Naco Brand Raw Bone Meal
Naco Brand Steamed Bone Meal
Naco Brand Sulphate of Ammonia
● Naco Brand Sulphate of Potash

Olds & Whipple, Inc., Hartford, Conn.

Double Manure Salts
H G Sulphate of Potash
Nitrate of Soda
O & W Acid Phosphate
O & W Blue Label Tobacco Fertilizer
O & W Bone Phosphate and Potash Compound
O & W Castor Pomace
O & W Complete Corn, Potato and Onion Fertilizer
O & W Complete Tobacco Fertilizer
O & W Dry Ground Fish
O & W Fish and Potash
O & W H G Potato Fertilizer
O & W H G Starter and Potash Compound
O & W H G Tobacco Starter
O & W Precipitated Bone
O & W Pure Bone Meal
O & W Spec Comp Corn, Onion and Potato Fertilizer
O & W Top Dressing for Grass
Sulphate of Ammonia

Pacific Manure & Fertilizer Co., 429 Davis St., San Francisco, California.

Groz-It Brand Pulverized Sheep Manure

Parmenter & Polsey Fertilizer Co., 41 North Market St., Boston, Mass.

Parmenter & Polsey 5-8-7 for Potatoes and Market Gardens
Parmenter & Polsey 4-8-4 for Potatoes, Corn and Vegetables
"P & P" Plymouth Rock Brand for all Crops 3-8-4

Platt Co., The Frank S., Inc., 450 State Street, New Haven, Conn.

Platco Special 4-8-6

Potash-Marl, Inc., 15 East 40th Street, New York, N. Y.

Potash-Marl

***Premier Poultry Manure Company,* 431 So. Dearborn St., Chicago, Ill.**

Premier Brand Pulverized Poultry Manure
Premier Brand Pulverized Sheep Manure

Pulverized Manure Company, 828 Exchange Ave., Union Stock Yards, Chicago, Ill.

Wizard Brand Manure
Wizard Brand Sheep Manure

Rogers & Hubbard Company, The, Portland, Conn.

Acid Phosphate
Castor Pomace
Cotton Seed Meal
4-8-4 Fertilizer
Garden Fertilizer
Ground Fish
Hubbard's "Bone Base" Fertilizer for Oats and Top Dressing
Hubbard's "Bone Base" Fertilizer for Seeding Down
Hubbard's "Bone Base" Soluble Corn and General Crops Manure.
Hubbard's "Bone Base" Soluble Potato Manure.
Hubbard's "Bone Base" Soluble Tobacco Manure
Hubbard's Pure Raw Knuckle Bone Flour
Hubbard's Strictly Pure Fine Bone
Nitrate of Soda
Richmond's Special
Rogers & Hubbard's All Soils-All Crops Fertilizer
Rogers & Hubbard's Climax Tobacco Brand.
Rogers & Hubbard's Corn and Grain Fertilizer
Rogers & Hubbard's High Potash Fertilizer
Rogers & Hubbard's Potato Fertilizer
Rogers & Hubbard's Tobacco Grower, Vegetable Formula
Sulphate of Potash

Royster Guano Company, F. S., 1604 Munsey Building, Baltimore, Md.

Dry Ground Fish
Muriate of Potash
Nitrate of Soda
Royster's Bully Guano
Royster's Fine Ground Bone Meal
Royster's Quality Trucker
Royster's 16% Acid Phosphate
Royster's Spearhead Guano
Royster's Top Dresser
Royster's Trucker's Delight
Royster's Valley Tobacco Formula
Royster's Wrapper Brand
Sulphate of Ammonia
Sulphate of Potash

Sanderson Fertilizer & Chemical Co., New Haven, Conn.

Sanderson's Acid Phosphate
Sanderson's Atlantic Coast Bone, Fish and Potash
Sanderson's Castor Pomace
Sanderson's Complete Tobacco Grower
Sanderson's Corn Superphosphate
Sanderson's Dry Ground Fish
Sanderson's Fine Ground Bone
Sanderson's Formula A
Sanderson's Formula B
Sanderson's Kelsey's Bone, Fish and Potash
Sanderson's Nitrate of Soda
Sanderson's Potato Manure
Sanderson's South American Sheep and Goat Manure
Sanderson's Top Dressing for Grass and Grain

Shoemaker & Co., Inc., M. L., Venango St. and Delaware Ave., Philadelphia, Pa.

Nitrate of Soda
Shoemaker's Bone Meal
"Swift-Sure" Bone Meal
"Swift-Sure" Crop Grower
"Swift-Sure" Potato No. 1
"Swift-Sure" Tobacco and General Use
"Swift-Sure" Tobacco Special
"Swift-Sure" Tobacco Starter

South Texas Cotton Oil Co., Victoria County, Texas (Agents, M. B. Jones & Co., Inc., Produce Exchange, New York, N. Y.)

43% Protein Cottonseed Meal

Springfield Rendering Company, Springfield, Mass.

Springfield Animal Brand 3-8-4
Springfield Market Garden Grower and Top Dresser
Springfield Special Potato, Onion and Vegetable 4-8-4
Springfield Tobacco Special, 5-4-5

Standard Agricultural Chemical Corporation, 2 Rector St., New York, N.Y.

Prepared Alphano Humus
Super-Alphano

Virginia-Carolina Chemical Company (of Delaware), Equitable Bldg., 120 Broadway (Room 2249), New York, N. Y.

Genuine Imported Kainit
Muriate of Potash
Nitrate of Soda
Pure Raw Bone
Sulphate of Ammonia
V-C Aroostook Potato Grower
V-C Champion Brand
V-C Double Owl Brand
V-C Fish, Phosphate and Potash Brand
V-C Indian Chief Brand
V-C Marvel Brand
V-C Perfection Brand
V-C Tip-Top Brand
V-C Universal Brand

Vitogro Chemical Co., 38 Middle St., Lowell, Mass.

Vitogro for Flowers, Shrubs and Vegetables
Vitogro for Lawns
Vitogro for Vegetables

Wilcox Fertilizer Company, 56 Main Street, Mystic, Conn.

Wilcox Acid Phospbate
Wilcox Corn Special
Wilcox Dry Ground Fish
Wilcox Fish and Potash
Wilcox 5-8-7 Fertilizer
Wilcox 5-10-5 Fertilizer
Wilcox 4-8-4 Fertilizer
Wilcox Grd. Steamed Bone

Wilcox Muriate of Potash
Wilcox Nitrate of Soda
Wilcox Potato and Vegetable Phosphate
Wilcox Tobacco Special

Woodruff & Sons, S. D., Orange, Conn.
Woodruff's Home Mixed Fertilizer

Worcester Rendering Company, Auburn, Mass.
Prosperity Brand Complete Dressing
Prosperity Brand Corn and Grain
Prosperity Brand Ground Tankage
Prosperity Brand Market Garden
Prosperity Brand Potato and Vegetable Fertilizer

INSPECTION OF 1924.

During the year, Mr. Churchill, the sampling agent of the Station, has visited ninety-six towns and villages in the State and has taken 592 official samples of fertilizers which number includes all the registered brands which were found on sale. These together with samples submitted by purchasers or others interested may be classified as follows:

CLASSIFICATION OF FERTILIZERS ANALYZED.

	Number of Samples	Page
I. *Containing Nitrogen as the chief active ingredient:*		
Nitrate of Soda	23	18
Sulphate of Ammonia	10	20
Castor Pomace	58	21
Cottonseed Meal	135	24
Linseed Meal	2	25
II. *Containing Phosphoric Acid as the chief active ingredient:*		
Raw Rock Phosphate	1	31
Precipitated Bone Phosphate	4	31
Dissolved Rock Phosphate or Acid Phosphate	20	31
III. *Containing Potash as the chief ingredient:*		
Carbonate of Potash	13	34
Muriate of Potash	13	34
Sulphate of Potash	26	34
Double Sulphate of Potash and Magnesia	6	40
IV. *Containing Nitrogen and Potash:*		
Nitrate of Potash	1	42
Nitrate of Potash and Soda	3	42
V. *Containing Nitrogen and Phosphoric Acid:*		
Dry Ground Fish	40	42
Tankage	18	43
Ground Bone	26	43
VI. *Mixed Fertilizers:*		
Containing Phosphoric Acid and Potash	2	52
Containing Nitrogen and Phosphoric Acid	3	52
Containing Nitrogen, Phosphoric Acid and Potash	299	53
Special and Home Mixtures	28	85
VII. *Miscellaneous fertilizers, amendments, waste products, etc.:*		
Wood Ashes	20	88
Sheep Manure, etc.	14	88
Sewage Sludge	2	92
Lime	46	92
Miscellaneous	58	100
Total	871	

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA.

Pure nitrate of soda contains 16.47 per cent of nitrogen. Commercial grades of this salt generally contain from 15 to 16 per cent of nitrogen which is equivalent to from 18.2 to 19.5 ammonia or 91 to 97 per cent nitrate of soda.

Twenty-three samples were examined and the results are given in Table I.

Sample **23039** was considerably under guaranty and a second sample, **23306**, from the same lot was also deficient. Sample **23013** was found to be deficient but a second sample of the same brand taken from a different source was well over the guaranty. Two samples, Nos. **23204** and **23205**, submitted by purchasers, were found to be considerably under the guaranty of 15 per cent nitrogen. The salt was red-brown in color and contained much insoluble matter. The Apothecaries Hall Company, who distributed this chemical, sold in original bags as received by them. They investigated and found that the low grade product constituted but a small part of their entire stock; they were allowed a rebate by the importers from whom they bought and reimbursed their customers accordingly.

Nitrogen from this source has cost from 20.6 to 28.9 cents per pound, the average being about 23.3 cents. Ton prices have ranged from $62.50 to $75.00.

We are uncertain about the guaranties on samples **21899, 21900, 21901** and **21902.** The jobbers claim the goods were guaranteed 15 per cent nitrogen, while the information submitted by the purchasers is that the salt was supposed to analyze 95 per cent nitrate of soda, which is about 15.60 per cent nitrogen. We have no information as to whether any adjustment was made or asked for.

TABLE I. ANALYSES OF NITRATE OF SODA.

Station No.	Manufacturer or Jobber.	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
22954	Sanderson Fertilizer and Chemical Co., New Haven.......	Station agent at the factory, New Haven.............	15.28	15.00
23237	Consolidated Rendering Co., Boston....	Station agent. Stock of The L. T. Frisbie Co., New Haven.................	15.50	15.22
23306	The E. B. Clark Seed Co., Milford.......	Station agent. Stock of D. L. Clarke & Sons, Milford....	13.72	15.00
21900	W. R. Grace Co., New York............	American Sumatra Tobacco Co., Bloomfield..........	15.52	15.60
21899	W. R. Grace Co., New York............	" "	15.40	.....
21901	W. R. Grace Co., New York............	" "	15.32	.....
21902	W. R. Grace Co., New York............	" "	15.24	.....
23141	The L. T. Frisbie Co., New Haven.......	W. T. Clark, Norwich.......	15.44	15.00
23067	F. S. Royster Guano Co., Baltimore.....	Station agent. Stock of W. S. Brown, Trumbull......	15.64	15.00
22904	East'n States Farmers' Exchange, Springfield	Station agent. Stock of H. H. McKnight, Ellington...	15.22	14.80
23130	Nitrate Agencies Co., Bound Brook, N. J.	Station agent. Stock of Joseph Adams, Westport...	14.96	15.00
23197	Wilcox Fertilizer Co., Mystic...........	Station agent. Stock of M. E. Thompson, Ellington...	15.50	15.00
23269	American Agricultural Chemical Co., New York............	Station agent. Stock of J. H. Paddock, Wallingford.....	15.26	15.00
22934	Olds & Whipple, Hartford.............	Station agent at factory.....	15.16	15.00
22898	Berkshire Fertilizer Co., Bridgeport....	Station agent at factory.....	15.06	14.80
22899	Apothecaries Hall Co., Waterbury........	Station agent. Stock of J. A. Glasnapp, West Cheshire..	15.32	14.80
22957	The Rogers & Hubbard Co., Portland.	Station agent at factory.....	15.16	15.00
23192	Virginia - Carolina Chemical Co., New York............	Station agent. Stock of E. O. Chapman, North Haven...	15.32	14.80
168	Armour Fertilizer Works, New York..	Station agent. Stock of F. L. Wadhams, Torrington..	15.72	14.81
23039	E. B. Clark Seed Co., Milford...........	Station agent. Stock of D. L. Clarke & Sons, Milford....	13.26	15.00
23013	Armour Fertilizer Works, New York..	Station agent. Stock of F. C. Benjamin, Danbury......	14.00	14.81
23205	Apothecaries Hall Co., Waterbury........	John H. R. Bishop, Cheshire	12.48	15.00
23204	Apothecaries Hall Co., Waterbury........	John H. R. Bishop, Cheshire	12.36	15.00

SULPHATE OF AMMONIA.

Ten samples were examined and the results are given in Table II. Pure ammonium sulphate contains 21.2 per cent of nitrogen, but the commercial grades usually contain about 20.5 per cent, which is equivalent to about 25 per cent of ammonia or about 97 per cent of ammonium sulphate.

As sold in the State this year this salt has contained from 20.2 to 20.9 per cent of nitrogen. Sample **23240** was a second sample drawn as a check on sample **23146**; both were substantially up to the guaranty. Sample **161** was a check on **23011** and exceeded the guaranty, whereas the first sample was slightly low. Sample **23395** showed a shortage of 0.33 per cent nitrogen. This was a small lot and was not resampled.

According to prices quoted, the cost per pound of nitrogen has ranged from 9.8 to 19.3 cents, the average being 16.6 cents; this is $3.32 per unit of nitrogen, or $2.73 per unit of ammonia. Ton prices have ranged from $40.00 to $79.00.

TABLE II. SULPHATE OF AMMONIA.

Station No.	Manufacturer or Jobber.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
23011	Armour Fertilizer Works, New York..	Station agent. Stock of F. A. Bartlett, Stamford........	20.36	20.56
23265	Virginia - Carolina Chemical Co., New York.............	Station agent. Stock of Rackliffe Bros., New Britain....	20.54	20.56
23153	Nitrate Agencies Co., New York.........	Station agent. Stock of Jos. Humphreys, Danbury.....	20.56	20.56
23146	L. T. Frisbie Co., New Haven...........	Sent by Walter Clark, Norwich....................	20.40	20.50
22922	Barrett Co., New York............	Station agent. Stock of Berkshire Fertilizer Co., Bridgeport....................	20.86	20.75
22939	Olds & Whipple, Inc., Hartford..........	Station agent at the factory..	20.80	20.58
23040	F. S. Royster Guano Co., Baltimore.....	Station agent. Stock of W. S. Brown, Trumbull.........	20.50	20.56
161	Armour Fertilizer Works, New York..	Station agent. Stock of F. A. Bartlett, Stamford........	20.60	20.56
23240	Consolidated Rendering Co., Boston....	Station agent. Stock of L. T. Frisbie Co., New Haven...	20.46	20.50
23395	Eastern States Farmers' Exchange, Springfield........	Station agent. Stock of H. H. McKnight, Ellington......	20.22	20.55

CASTOR POMACE.

Castor pomace is the residue left after removing the oil from the castor bean. It is actively poisonous to stock and should be stored with due precautions on that account. As a fertilizer it is used chiefly with cottonseed meal in tobacco mixtures. While valuable chiefly for its nitrogen content it contains also about one per cent of potash and two per cent of phosphoric acid.

Fifty-eight samples were analyzed and the results are given in Table III. Fifteen were sampled by the station agent; the remainder were sampled and submitted by purchasers.

Sample **22813** was submitted by the purchaser and was drawn from three bags. The stock was left over from the previous year but when bought was guaranteed to contain 5 per cent of nitrogen. Sample **22951** was sampled by the station agent from six bags of the lot, and samples **22953** and **22960** were taken from each of two bags which were represented in the original purchaser's sample. The two single bag samples show a variation in nitrogen of about 1 per cent. The entire purchase of the previous year cannot be adequately judged, however, by these samples from the left-over stock.

In general, this material has been sold this year under a guaranty of 4.52 per cent nitrogen, which is equivalent to 5.50 per cent of ammonia. In fifty samples where guaranties are known there were forty in which the guaranties were exceeded and ten in which they were not met; but for the total number there was an average over-run of 0.17 per cent of nitrogen.

At the prices quoted to us, confidentially or otherwise, the average cost per ton is **$29.76**. The average nitrogen content is 4.75 per cent. Disregarding the potash and phosphoric acid contents, nitrogen has cost 31.3 cents per pound, which is **$6.26** per unit of nitrogen or **$5.13** per unit of ammonia. *If allowance is made for the potash and phosphoric acid present at the rate of four cents per pound each, then the cost per pound of nitrogen is about 28.8 cents.*

TABLE III. ANALYSES OF CASTOR POMACE.

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	The American Agricultural Chemical Co., New York City.			
22926	....	Station agent from stock of Geo. S. Phelps & Co., Thompsonville...........	4.77	4.53
	Apothecaries Hall Co., Waterbury, Conn.			
22199	7341..............	Hatheway & Steane, Hartford	5.39	....
22200	35014.............	" "	4.86	....
22201	215754............	" "	4.66	....
22202	63787.............	" "	4.69	....
22664	11260 P. A. R........	Spencer Bros., Suffield.......	5.19	4.52
22790	32790 H. O..........	" "	4.79	4.52
22793	238188 N. Y. C......	" "	5.11	4.52
	Baker Castor Oil Co., New York, N. Y.			
21951	75785.............	American Sumatra Tobacco Co., Bloomfield..........	4.46	4.52
21952	81073.............	" "	4.83	4.52
21965	171752............	" "	4.81	4.52
21966	153850............	" "	4.87	4.52
21967	253457............	" "	4.97	4.52
21968	159471............	" "	4.58	4.52
21985	47750.............	" "	5.12	4.52
21986	96146.............	" "	4.48	4.52
22250	88268.............	" "	4.19	4.52
22294	255465............	" "	4.57	4.52
22295	93176.............	" "	4.68	4.52
22296	49563.............	" "	4.45	4.52
22297	12105.............	" "	5.28	4.52
22298	84611.............	" "	4.73	4.52
22354	17980.............	" "	4.36	4.52
22355	153676............	" "	4.00	4.52
22359	96146.............	" "	5.00	4.52
22360	75785.............	" "	4.53	4.52
22369	34670.............	" "	4.78	4.52
22416	86215.............	" "	5.46	4.52
22419	91929.............	" "	5.11	4.52
22436	102234............	" "	4.62	4.52
22437	98832.............	" "	4.80	4.52
22438	30002.............	" "	4.29	4.52
22439	88268.............	" "	4.70	4.52
22448	7313..............	" "	4.38	4.52
22449	45963.............	" "	4.76	4.52
22450	80744.............	" "	4.84	4.52

TABLE III. ANALYSES OF CASTOR POMACE—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Baker Castor Oil Co., New York, N. Y.			
22464	17980	American Sumatra Tobacco Co., Bloomfield	4.69	4.52
22465	153676	" "	4.30	4.52
22472	261920	" "	4.62	4.52
22786	156063, R. I.	John S. Leonard, Burnside	4.82	4.52
23227		Station agent from stock of Olds & Whipple, Hartford	5.01	4.50
23275		Station agent from stock of F. H. Thrall, Windsor	5.02	4.50
	Berkshire Fertilizer Co. Bridgeport, Conn.			
22813		Station agent from stock of Frank Lanati, Windsor Locks	3.88[1]	....
22872		Station agent from stock of T. W. Ryan, Stratford	4.47	4.50
22951		Station agent from stock of Frank Lanati, Windsor Locks	4.26[1]	....
22952		" "	3.55[1]	....
22953		" "	4.51[1]	....
22960		Station agent from stock of J. E. Lathrop, Burnside	4.63	4.50
	E. D. Chittenden Co., Bridgeport, Conn.			
23270		Station agent from stock of E. J. Bantle, Glastonbury	4.28	4.50
	L. T. Frisbie Co., New Haven, Conn.			
163		Station agent from stock of G. O. Case, Burnside	4.61	4.52
22962		Station agent from stock of T. J. Coleman, Warehouse Point	4.40	4.52
	Nitrate Agencies Co., New York, N. Y.			
23417	Naco	Station agent from stock of E. N. Austin, Suffield	4.65	4.93
	Olds & Whipple, Hartford, Conn.			
22927		Station agent at factory	5.19	4.94

[1] Stock of 1923, omitted from average.

TABLE III. ANALYSES OF CASTOR POMACE—*Concluded.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Olds & Whipple, Hartford, Conn.			
23072	Thum. 48544 M. C. R. R.	H. E. Wells, Windsor Locks	5.16	4.94
23073	Thum. 226956 N.Y.C.	" "	4.90	4.94
23280	....	L. Wetstone & Sons, Inc., Hartford	5.07	4.52
	The Rogers & Hubbard Co., Portland, Conn.			
22958	....	Station agent at factory.....	5.05	5.00
	Sanderson Fertilizer & Chemical Co., New Haven, Conn.			
22988	....	Station agent at factory.....	4.71	4.53

COTTONSEED MEAL.

One hundred and thirty-five samples of cottonseed meal have been analyzed and the results are given in Table IV. The grades may be classified as follows:

36 per cent protein containing 5.76 per cent nitrogen equivalent to 7.00 per cent ammonia, 16 samples.

41 per cent protein containing 6.56 per cent nitrogen equivalent to 8.00 per cent ammonia, 82 samples.

43 per cent protein containing 6.88 per cent nitrogen equivalent to 8.30 per cent ammonia, 17 samples.

Four samples have odd guaranties and for 16 samples no guaranties were submitted. There were no samples bearing a guaranty of 38.56 per cent protein (6.17 per cent nitrogen equivalent to 7.50 per cent ammonia).

Of these samples where guaranties are known 82 equaled or exceeded their guaranties and 36 did not. As an average for all samples there was 0.15 per cent of nitrogen in excess of the guaranty.

Reckoning nitrogen at its average cost as deduced from data obtained this year, viz., 39.1 cents per pound, deficiencies in money value in excess of $1.00 per ton were shown in only 15 samples. This is making no allowance for about 3 per cent of phosphoric

acid and 2 per cent of potash which cottonseed meal normally contains and which are fairly valued at 4 cents per pound each.

So far as we have information as to prices, the cost of nitrogen in cottonseed meal has averaged 39.1 cents per pound, and nitrogen has been purchased at somewhat better advantage in the higher grades as appears in the subjoined summary, Table V.

TABLE V. SUMMARY OF DATA ON COTTONSEED MEAL.

GRADE.	Number of Samples.	Average Nitrogen. %	Average Cost per Ton.	Average Cost of Nitrogen, cents per Pound.
36 per cent (5.76 N)	16	5.79	$48.90[1]	42.2
41 per cent (6.58 N)	82	6.76	51.93[2]	38.4
43 per cent (6.88 N)	17	7.02	55.99[3]	39.2
Odd per cent	4	6.00	....	....
No guaranty	16	6.73	50.59[4]	37.6
Total and averages	135	6.66	52.13[5]	39.1

LINSEED MEAL.

Two samples purchased by Hatheway & Steane from Olds & Whipple of Hartford were submitted by the purchasers. Guaranties were not given. The samples, **23174** and **23175**, contained 5.77 and 5.96 per cent of nitrogen respectively, equivalent to 7.02 and 7.25 per cent of ammonia. *The price quoted was $45.50 per ton; thus nitrogen cost about 38.7 cents per pound.*

[1] Based on 12 quotations.
[2] Based on 11 quotations.
[3] Based on 15 quotations.
[4] Based on 11 quotations.
[5] Based on 49 quotations.

TABLE IV. ANALYSES OF COTTONSEED MEAL.

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Ashcraft-Wilkinson Co., Atlanta, Ga.			
23210	Helmet............	Station agent from stock of *Meech & Stoddard, Middletown*..................	6.43	6.58
23212	Monarch...........	" "	6.59	6.88
23211	Paramount.........	" "	5.71	5.76
201	Paramount, 47866 A. C. L..........	The Coles Co., Middletown..	6.16	5.76
22531	Paramount, 30277 A. C. L..........	" "	5.83	5.76
22561	Paramount, 42996 A. C. L..........	" "	5.80	5.76
22777	Paramount, 48488 A. C. L..........	" "	5.89	5.76
22666	....	Clark Bros., Windsor.......	6.11	6.37
22667	....	Clark Bros., Windsor........	5.94	6.37
	S. P. Davis, Little Rock, Ark.			
157	Beauty............	Station agent from stock of A. D. Bridge's Sons, Hazardville..............	5.86	5.75
153	Steerboy...........	Station agent from stock of Willimantic Grain Co., Willimantic.............	7.17	6.88
	Humphreys-Godwin Co., Memphis, Tenn.			
139	Bull. 78627 York.....	The Coles Co., *Middletown*..	6.78	6.88
149	Bull...............	Station agent from stock of F. C. Benjamin, Danbury	7.01	6.87
22663	Bull. 75278 N. H.....	Spencer Bros., Inc., Suffield	6.96	6.88
22792	Bull 90739 N. H.....	Spencer Bros, Inc., Suffield	6.94	6.88
22858	Bull. 31921, Hazardville.............	L. B. Haas & Co., Inc., Hartford....................	6.96	6.88
22891	Bull. 23808 M. D.....	Hartz Bros., Burnside......	6.89	6.88
22910	Bull...............	Clark Bros., Windsor.......	6.88	....
23032	Bull...............	Michael Flemming, *Suffield*..	7.70	6.88
23137	Bull. 93083 N. H.....	Spencer Bros. Inc., Suffield..	7.71	6.88
23138	Bull. 10650 C. N. E...	Spencer Bros. Inc., Suffield..	7.35	6.88
23307	Bull. 35465 M. E. C..	Geo. S. Phelps & Co........	7.33	6.88
23326	Bull. 88989 N. H.....	Spencer Bros., Inc., Suffield..	6.74	6.88
23327	Bull. 11244..........	" "	6.87	6.88
23328	Bull. 62034 B. & M. .	" "	6.71	6.88

TABLE IV. ANALYSES OF COTTONSEED MEAL—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Humphreys-Godwin Co., Memphis, Tenn.			
22997	Bull	H. C. Nelson, West Suffield	6.91	6.88
22422	Danish, 21401 N. S.	The Coles Co., Middletown	5.77	5.76
22662	Danish, 29898 A.C.L.	The Coles Co., Middletown	5.49	5.76
22933	Danish	Geo. S. Phelps & Co., Thompsonville	5.95	5.75
23287	Danish, 46812 A.C.L.	Spencer Bros., Inc., Suffield	5.49	5.75
23288	Danish, 67079	" "	5.93	5.75
23289	Danish, 37905 A.C.L.	" "	5.79	5.75
22251	Dixie, 101407 L.& N.	The Coles Co., Middletown	6.38	6.58
22488	Dixie, 31170	American Sumatra Tobacco Co., Bloomfield	6.55	6.58
22497	Dixie, 15794	American Sumatra Tobacco Co., Bloomfield	6.66	6.58
23166	Dixie, 36514	Hatheway & Steane, Hartford	6.69	....
23199	*Dixie, 16447*	*Apothecaries Hall Co., Waterbury*	6.15	6.58
23222	Dixie, 81874 N. H.	G. Stephen Potwine, Warehouse Point	6.44	6.58
23276	Dixie, 43621	L. Wetstone & Sons, Inc., Hartford	6.65	6.58
23277	Dixie, 14954	" "	6.63	6.58
23278	Dixie, 91801	" "	6.63	6.58
23279	Dixie, 74337	" "	6.47	6.58
23281	Dixie, 35573	" "	6.65	6.58
23282	Dixie, 36260	" "	6.49	6.58
23164	Dixie, 63253	Hatheway & Steane, Hartford	6.47	....
23165	*Dixie, 31048*	" "	7.00	....
23167	Dixie, 39544	" "	6.52	....
23168	Dixie, 244814	" "	7.00	....
23169	Dixie, 10447	" "	6.64	....
23170	Dixie, 27292	" "	7.00	....
23171	Dixie, 37185	" "	6.63	....
23172	Dixie, 60718	" "	7.30	....
23173	Dixie, 28511	" "	6.28	....
22911	90083	Clark Bros., Windsor	6.81	....
22299	33861	American Sumatra Tobacco Co., Bloomfield	6.58	6.58
22300	63743	" "	7.34	6.58
22301	81497	" "	7.40	6.58
22302	89420	" "	7.44	6.58
22303	78742	" "	7.42	6.58
22304	93186	" "	7.14	6.58
22305	72820	" "	7.26	6.58
22361	92340	" "	7.36	6.58

TABLE IV. ANALYSES OF COTTONSEED MEAL—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Humphreys-Godwin Co., Memphis, Tenn.			
22352	91544	American Sumatra Tobacco Co., Bloomfield	7.38	6.58
22353	20125	" "	7.20	6.58
22363	91906	" "	6.88	6.58
22364	72954	" "	6.70	6.58
22365	90294	" "	7.00	6.58
22366	564320	" "	6.88	6.58
22367	160758	" "	6.76	6.58
22368	76269	" "	6.89	6.58
22370	16028	" "	7.06	6.58
22377	83038	" "	6.59	6.58
22378	87967	" "	6.46	6.58
22379	93694	" "	6.78	6.58
22380	87799	" "	6.47	6.58
22381	76490	" "	7.00	6.58
22382	73020	" "	6.67	6.58
22383	76100	" "	7.18	6.58
22384	88627	" "	6.97	6.58
22385	84866	" "	6.50	6.58
22407	215399	" "	7.04	6.58
22408	31399	" "	6.63	6.58
22409	83078	" "	6.52	6.58
22410	89632	" "	7.10	6.58
22411	92897	" "	6.59	6.58
22412	88599	" "	6.45	6.58
22413	91579	" "	6.41	6.58
22414	540783	" "	7.50	6.58
22415	18125	" "	6.60	6.58
22440	90415	" "	6.57	6.58
22451	81438	" "	6.68	6.58
22452	74828	" "	7.28	6.58
22453	29148	" "	6.81	6.58
22454	47369	" "	7.46	6.58
22455	67508	" "	6.74	6.58
22456	85716	" "	6.82	6.58
22457	33372	" "	6.62	6.58
22458	92847	" "	6.67	6.58
22459	21806	" "	6.74	6.58
22460	56458	" "	6.81	6.58
22461	70995	" "	6.62	6.58
22466	202843	" "	6.51	6.58
22468	88107	" "	6.58	6.58
22469	88691	" "	6.40	6.58
22470	78291	" "	7.00	6.58

TABLE IV. ANALYSES OF COTTONSEED MEAL—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Humphreys-Godwin Co., Memphis, Tenn.			
22471	40360	American Sumatra Tobacco Co., Bloomfield	6.75	6.58
22473	200726	" "	6.83	6.58
22474	90716	" "	6.80	6.58
22475	8634	" "	6.61	6.58
22481	64018	" "	6.77	6.58
22482	245905	" "	6.60	6.58
22483	230723	" "	6.57	6.58
22484	220223	" "	6.52	6.58
22490	19330	" "	6.82	6.58
22491	261624	" "	6.60	6.58
22492	102218	" "	6.56	6.58
22493	331174	" "	6.66	6.58
22496	171397	" "	6.48	6.58
22499	115440	" "	6.72	6.58
22500	87372	" "	6.58	6.58
22501	32059	" "	6.90	6.58
22502	72782	" "	6.47	6.58
22503	89230	" "	6.45	6.58
22791	60455 B. & M.	Spencer Bros., Inc., Suffield	6.79	6.88
22630	42378	L. B. Haas & Co., Inc., Hartford	5.94	6.37
	L. B. Lovitt & Co., Memphis, Tenn.			
23213	Thirty-six Brand	Station Agent. Stock of W. L. Thorp, North Haven	5.51	5.75
	Memphis Cottonseed Products Co., Memphis, Tenn.			
23208	Durham	Station agent. Stock of R. G. Davis & Sons, New Haven	6.38	5.75
	R. N. Neal & Co., Inc., Memphis, Tenn.			
151	Triangle	Station agent. Stock of Yantic Grain & Products Co., Norwich	5.60	5.75
23218	Triangle	Station agent. Stock of Geo. E. Ackley Co., New Milford	6.32	6.58

TABLE IV. ANALYSES OF COTTONSEED MEAL—*Concluded.*

Station No.	Manufacturer or Jobber, Car No. or Mark.	Purchased, Sampled or Sent by	Per cent Nitrogen. Found.	Per cent Nitrogen. Guaranteed.
	Olds & Whipple, Hartford, Conn.			
22631	36824	L. B. Haas & Co., Inc., Hartford	5.99	6.37
22804	61141, B. & M.	Huntington Bros., Windsor	7.05	....
22806	22019	" "	7.07	....
22807	80886	" "	6.53	....
22805	39250	" "	6.09	....
	The Rogers & Hubbard Co., Middletown, Conn.			
148	....	Station agent from factory	5.82	5.75

II. RAW MATERIALS CHIEFLY VALUABLE FOR PHOSPHORIC ACID.

RAW ROCK PHOSPHATE.

Only one sample was analyzed.

10. Phos-Pho-Flour. Sold by W. L. Mitchell, New Haven, and sampled by the Station agent from stock of H. O. Daniels, Middletown.

It was guaranteed to contain 28 per cent of total phosphoric acid and 30.95 per cent was found.

PRECIPITATED BONE PHOSPHATE.

The bone phosphate of commerce is obtained as a by-product in the manufacture of gelatin and consists largely of dicalcium phosphate. The phosphoric acid in this material is practically all "available."

Four samples were analyzed, all of which exceeded their guaranties. *At the price quoted, available phosphoric acid has cost 6.3 cents per pound. The ton price was $50.00.*

Analyses are given in Table VI.

DISSOLVED ROCK PHOSPHATE OR ACID PHOSPHATE.

This material is the product made by treating raw rock phosphate with sulphuric acid whereby the phosphorus is largely converted into "available" forms. In acid phosphates most of the available phosphoric acid is soluble in water.

The prevailing guaranty is 16 per cent of "available" phosphoric acid, and this amount was exceeded in all of the twenty samples examined.

As regards "available" phosphoric acid this material has varied in composition within the limits of about 50 pounds per ton. The price, however, has ranged from $14.00 to $30,00 and the cost per pound of available phosphoric acid has accordingly varied from 4.2 to 9.2 cents. *On the average, acid phosphate this year has contained 16.73 per cent of available phosphoric acid, which at the average price ($21.11) per ton has made the cost of this constituent 6.3 cents per pound, or $1.26 per unit.*

Analyses are given in Table VII.

TABLE VI. ANALYSES OF PRECIPITATED BONE PHOSPHATE.

Station No.	Manufacturer or Wholesale Dealer.	Place of Sampling.	Phosphoric Acid.			
			Citrate-insoluble.	Total.	"Availa	
					Found.	
	Sampled by Station:		%	%	%	
23016	Apothecaries Hall Co., Waterbury...........	At Factory, East Windsor.	0.91	41.20	40.29	3
22918	Berkshire Fertilizer Co., Bridgeport...........	At Factory.............	0.37	41.04	40.67	3
22928	Olds & Whipple, Inc., Hartford.............	At Factory.............	0.50	40.42	39.92	3
	Sampled by Purchaser:					
22463	Olds & Whipple, Inc., Hartford.............	American Sumatra Tobacco, Co., Bloomfield.....	0.25	38.44	38.19	.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Citrate-insoluble.	Total.	"Available" Found.	"Available" Guaranteed.	Station No.
	Sampled by Station:		%	%	%	%	
23064	American Agricultural Chemical Co., New York	C. F. Allen, Warehouse Point	0.15	16.83	16.68	16.00	23064
23184	Apothecaries Hall Co., Waterbury	Sampled at Factory	1.38	17.68	16.30	16.00	23184
23007	Armour Fertilizer Works, New York	Robert Greenbacker, Meriden	0.53	16.69	16.06	16.00	23007
22870	Berkshire Fertilizer Co., Bridgeport	T. W. Ryan, Stratford	0.20	17.49	17.29	16.00	22870
23228	Bowker Fertilizer Co., New York	Geo. E. Ackley Co., New Milford	0.15	16.40	16.25	16.00	23228
23271	E. D. Chittenden Co., Bridgeport	J. E. Stoddard, Abington	0.53	16.73	16.20	16.00	23271
23133	Coe-Mortimer Co., New York	J. B. McArdle, Greenwich	0.15	16.48	16.33	16.00	23133
23239	Consolidated Rendering Co., Boston	L. T. Frisbie, New Haven	0.15	17.58	17.43	16.00	23239
22902	Eastern States Farmers' Exchange, Springfield	H. H. McKnight, Ellington	0.49	16.52	16.03	16.00	22902
99	International Agricultural Corporation, Boston	Alva Taylor, West Suffield	0.78	17.80	17.02	16.00	99
23131	Nitrate Agencies Co., Bound Brook, N. J.	Joseph Adams, Westport	0.28	16.43	16.15	16.00	23131
22936	Olds & Whipple, Inc., Hartford	Sampled at Factory	0.72	17.63	16.91	16.00	22936
22956	The Rogers & Hubbard Co., Portland	Sampled at Factory	0.12	18.66	18.54	16.00	22956
23019	The Rogers & Hubbard Co., Portland	The Lyman Farm, Middlefield	0.41	17.21	16.80	16.00	23019
23068	F. S. Royster Guano Co., Baltimore	W. S. Brown, Trumbull	1.63	17.76	16.13	16.00	23068
22985	Sanderson Fertilizer & Chemical Co., New Haven	Sampled at Factory	0.08	16.73	16.65	16.00	22985
23194	Virginia-Carolina Chemical Co., New York	E. O. Chapman, North Haven	1.28	18.23	16.95	16.00	23194
23196	Wilcox Fertilizer Co., Mystic	W. E. Thompson, Ellington	0.20	18.05	17.85	17.00	23196
	Sampled by Purchaser:						
22230	E. D. Chittenden Co., Bridgeport	A. B. Lapsly, Pomfret Center	0.74	17.46	16.72	16.00	22230
23139	The L. T. Frisbie Co., New Haven	W. T. Clark, Norwich	1.68	17.88	16.20	16.00	23139

III. RAW MATERIALS CONTAINING POTASH.

CARBONATE OF POTASH.

Pure carbonate of potash contains 68.2 per cent of actual potash (K_2O), but commercial grades usually contain from 60 to 65 per cent. Most of the samples submitted were guaranteed to contain 96 per cent carbonate of potash which is equivalent to 65.44 per cent actual potash.

Thirteen samples were analyzed, all but one being submitted by purchasers. Two samples, Nos. **22494** and **22495**, failed to meet their guaranties by 3.01 and 2.18 per cent respectively; these samples were from the same stock as two previous samples viz., **22358** and **22356**, both of which more nearly approached the guaranty.

Analyses are given in Table VIII.

MURIATE OF POTASH.

The usual commercial grade of this salt is about 80 per cent pure containing about 50.5 per cent actual potash. Because it readily absorbs moisture, guaranties are often placed somewhat lower, viz., 48 to 50 per cent. The prevailing guaranty for samples examined this year was 50 per cent.

Thirteen samples were analyzed, four of which contained considerably less than 48 per cent. Sample **22871** was from three bags which represented the remainder of a four-ton lot. The analysis may not, therefore, be representative of the whole shipment.

Nos. **23140** and **23324** were purchaser's samples from the same lot. The goods were sold by the L. T. Frisbie Company and obtained by them from the Consolidated Rendering Company of Boston. These two samples were considerably below the guaranty of 50 per cent; an official sample, **23242**, taken by the Station agent at the plant of the Frisbie Company exceeded the guaranty by nearly 1.5 per cent.

The average for all samples is close to 50 per cent (49.92), of potash which, at the average of prices quoted, $44.40, makes the cost of potash in this material 4.5 cents per pound or 90 cents per unit. The lowest cost noted is 3.8 cents, and the highest is 5 cents per pound.

Analyses are given in Table VIII.

HIGH GRADE SULPHATE OF POTASH.

The commercial grades of this salt generally contain about 48.0 per cent of potash which is approximately 90 per cent sulphate of potash.

Twenty-six samples were examined of which ten were drawn by the Station agent and the remainder by purchasers. The

official samples substantially met or exceeded their guaranties. Several samples, submitted by purchasers, while of fair average quality did not meet the guaranties quoted for them which were over 50 per cent. Two, **22350** and **22535**, were considerably under 48 per cent.

The average potash-content was 49.1 per cent and the cost per pound, based upon the few prices quoted, averaged 5.5 cents.

Seven samples, representing early season purchases of the American Sumatra Tobacco Co., were submitted by the purchasers. The samples purported to be high grade sulphate but, on analysis, only one conformed to that grade, the others containing from 30 to 40 per cent of potash with considerable and varying amounts of chlorine and magnesia. Investigation by the Station agent showed that this shipment was received in the original import sacks distinguished only by serial numbers; and that there were two grades in the lot, one in bags marked 419 and the other in bags marked 482 and 600. The low grade stock was included in the shipment by mistake and replacement was made.

Analyses are given in Table VIII.

TABLE VIII. ANALYSES OF POTASH SALTS.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.	Station No.
	Carbonate of Potash. *Sampled by Station:*		%	%	
23234	Apothecaries Hall Co., Waterbury........	Sampled at Factory....................	65.86	62.00	23234
	Sampled by Purchaser:				
22417	....	American Sumatra Tobacco Co., Bloomfield	66.56	.....	22417
22418	....	" "	61.44	.....	22418
22214	A. Klipstein, New York City............	" "	66.28	65.44	22214
22215	" "	" "	66.68	65.44	22215
22248	" "	" "	65.72	65.44	22248
22249	" "	" "	66.32	65.44	22249
22306	" "	" "	64.96	65.44	22306
22356	" "	" "	65.16	65.44	22356
22357	" "	" "	65.52	65.44	22357
22358	" "	" "	64.88	65.44	22358
22494	" "	" "	62.43	65.44	22494
22495	" "	" "	63.26	65.44	22495
	Muriate of Potash. *Sampled by Station:*				
22923	Apothecaries Hall Co., Waterbury........	J. A. Glasnapp, West Cheshire...........	55.90	50.00	22923
23012	Armour Fertilizer Works, New York......	F. A. Bartlett, Stamford................	52.08	48.00	23012

TABLE VIII. ANALYSES OF POTASH SALTS—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.	Station No.
	Muriate of Potash—*Continued.* *Sampled by Station:*		%	%	
22871	Berkshire Fertilizer Co., Bridgeport	T. W. Ryan, Stratford	49.12	50.00	22871
23242	Consolidated Rendering Co., Boston, Mass.	The L. T. Frisbie Co., New Haven	51.45	50.00	23242
164	Eastern States Farmers' Exchange, Springfield, Mass.	H. H. McKnight, Ellington	49.47	50.00	164
305	" "	" "	44.89	50.00	305
22905	" "	" "	46.83	50.00	22905
190	Nitrate Agencies Co., Bound Brook, N. J.	E. N. Austin, Suffield	49.62	50.00	190
23151	Nitrate Agencies Co., Bound Brook, N. J.	H. P. Beers, Greens Farms	51.25	50.00	23151
23297	Wilcox Fertilizer Co., Mystic	*Sampled at Factory*	55.59	50.00	23297
	Sampled by Purchaser:				
23365	American Agricultural Chemical Co., New York	R. E. Upson, Marion	50.62	48.00	23365
23140	The L. T. Frisbie Co., New Haven	W. T. Clark, Norwich	46.86	50.00	23140
23324	The L. T. Frisbie Co., New Haven	W. T. Clark, Norwich	45.26	50.00	23324
	Sulphate of Potash. *Sampled by Station:*				
22263	S. P. 419	American Sumatra Tobacco Co., Bloomfield	50.36	.....	22263
22925	American Agricultural Chemical Co., New York	Geo. S. Phelps & Co., Thompsonville	49.47	48.00	22925

TABLE VIII. ANALYSES OF POTASH SALTS—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.	Station No.
	Sulphate of Potash—*Continued.*				
	Sampled by Station:		%	%	
6	Apothecaries Hall Co., Waterbury	Sampled at Factory	47.44	48.00	6
23018	Apothecaries Hall Co., Waterbury	" "	47.76	48.00	23018
22919	Berkshire Fertilizer Co., Bridgeport	" "	50.15	48.00	22919
23241	Consolidated Rendering Co., Boston, Mass.	The L. T. Frisbie Co., New Haven	49.47	48.00	23241
189	Nitrate Agencies Co., Bound Brook, N. J.	E. N. Austin, Suffield	50.20	48.00	189
23158	Nitrate Agencies Co., Bound Brook, N. J.	H. P. Beers, Greens Farms	49.50	48.00	23158
22938	Olds & Whipple, Inc., Hartford	Sampled at Factory	50.24	48.65	22938
23431	The Rogers & Hubbard Co., Portland	Sampled at Factory	49.61	48.00	23431
	Sampled by Purchaser:				
22420	..... S. P. 500	American Sumatra Tobacco Co., Bloomfield	50.88	.....	22420
22563	30567 S. P. 484	" "	49.69	51.29	22563
22564	26174 S. P. 338	" "	48.77	50.64 [1]	22564
22565	30567 S. P. 218	" "	51.00	52.48 [2]	22565
22566	30567 S. P. 354	" "	48.60	.....	22566
22567	36081 S. P. 498	" "	48.20	.....	22567
22568	36081 S. P. 494	" "	49.50	.....	22568

[1] Guaranteed 93.6 per cent sulphate of potash.
[2] Guaranteed 97.01 per cent sulphate of potash.

TABLE VIII. ANALYSES OF POTASH SALTS—*Concluded.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.	Station No.
	Sulphate of Potash—*Concluded.* *Sampled by Purchaser:*		%	%	
22583	8812 S. P. 218	American Sumatra Tobacco Co., Bloomfield	51.36	52.48 [3]	**22583**
22584	8812 S. P. 338	" "	47.68	50.64 [4]	**22584**
22585	8812 S. P. 484	" "	50.32	51.29 [5]	**22585**
22586	8812 S. P. 354	" "	49.24	.....	**22586**
22587	8812 S. P. 492	" "	49.16	.....	**22587**
22588	8812 S. P. 498	" "	48.44	.....	**22588**
22589	8812 S. P. 355	" "	49.76	.....	**22589**
22350	Olds & Whipple, Inc., Hartford	Huntington Bros., Windsor	46.44	48.65	**22350**
22535	Olds & Whipple, Inc., Hartford	Clark Bros., Windsor	43.32	48.65	**22535**

[3] Guaranteed 97.01 per cent sulphate of Potash.
[4] Guaranteed 93.6 per cent sulphate of Potash.
[5] Guaranteed 94.8 per cent sulphate of Potash.

DOUBLE SULPHATE OF POTASH AND MAGNESIA OR "DOUBLE MANURE SALTS".

Six samples were analyzed this year and the results are given in Table IX.

This salt contains potash and magnesia combined as sulphate and is relatively free from chlorine, which makes it well adapted for use in tobacco fertilizers. It generally contains from 25 to 28 per cent of potash and from 8 to 12 per cent of magnesia. In the last three years, however, seven out of twenty-one samples examined by us have shown amounts of magnesia less than 8 per cent, these ranging from 6.6 down to as low as 3 per cent. In only four of the total number has chlorine exceeded 4 per cent and in none has it reached 5 per cent.

The average potash content in samples analyzed this year is 27.67 per cent and the average cost per pound of potash, at the prices quoted, is 5.1 cents.

TABLE IX. ANALYSES OF DOUBLE MANURE SALTS.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash.		Magnesia.	Chlorine.	Station No.
			Found.	Guaranteed.			
	Sampled by Station:		%	%	%	%	
22931	American Agricultural Co., New York..	Spencer Bros., Suffield.......	27.97	26.00	11.51	1.81	22931
23215	Apothecaries Hall Co., Waterbury.....	Station agent at factory.....	28.98	26.00	2.97	1.05	23215
22920	Berkshire Fertilizer Co., Bridgeport....	" "	26.18	26.00	6.62	2.48	22920
22935	Olds & Whipple, Inc., Hartford.......	" "	27.60	26.00	11.46	1.97	22935
	Sampled by Purchaser:						
22682	Olds & Whipple, Inc., Hartford.......	L. B. Haas & Co., Hartford..	26.52	.....	4.34	0.47	22682
22949	Olds & Whipple, Inc., Hartford.......	L. B. Haas & Co., Hartford..	28.75	26.00	.....	.....	22949

IV. RAW MATERIALS CONTAINING NITROGEN AND POTASH.

One sample of nitrate of potash and three of nitrate of soda and potash have been analyzed, all sampled by the Station agent.

23020. Nitrate of potash from Calcutta, India. Stock of the Lyman Farm, Middlefield.

22924 Nitrate of Soda and Potash. Sold by Apothecaries Hall, sampled from stock of J. A. Glasnapp, West Cheshire.

23416. Nitrapo. Sold by Nitrate Agencies Co., sampled from stock of F. H. Thrall, Windsor.

191. Nitrapo. Sold by Nitrate Agencies Co., sampled from stock of E. N. Austin, Suffield.

Analyses are given in Table X.

TABLE X. ANALYSES OF NITRATE OF POTASH, ETC.

Station No.	**23020**	**22924**	**23416**	**191**
Nitrogen:				
found	12.60	15.46	14.30	11.78
guaranteed	.....	*14.80*	*14.80*	*14.80*
Equivalent ammonia:				
found	15.32	18.80	17.39	14.32
guaranteed	.....	18.00	18.00	18.00
Potash:				
found	43.45	14.11	17.15	12.41
guaranteed	.....	12.00	15.00	15.00

The price quoted in case of sample **22924** was $75.00 per ton. *Allowing 5 cents per pound for potash the cost of nitrogen was 19.6 cents, which is a little less than the minimum cost calculated for nitrate of soda this year.*

V. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

DRY GROUND FISH.

Forty samples were analyzed and the results are given in Table XI.

The prevailing guaranty for nitrogen was 8.23 per cent, equivalent to 10 per cent of ammonia. The guaranties for phosphoric acid varied from 4 to 9 per cent.

The average nitrogen content found was 8.45 per cent, equivalent to 10.27 per cent of ammonia, and the average for phosphoric acid was 7.37 per cent.

Based upon the average cost per ton as quoted, and allowing 5 cents per pound for phosphoric acid, nitrogen in this material has cost about 37.9 cents per pound. There were considerable overruns in phosphoric acid in most cases, assuming an average where no guaranty was given. Taking these into account, there were no deficiencies in nitrogen which exceeded **$1.00** per ton except in **23418** where the estimated shortage was **$1.14**.

TANKAGE.

Tankage is prepared from animal refuse secured from slaughter houses and meat markets and may contain considerable and varying amounts of bone. The distinction between meat tankage and bone tankage is not sharply drawn but, in general, tankage with 5 per cent or less of nitrogen and 15 per cent or more of phosphoric acid shows considerable bone and is often sold as bone and meat tankage. As the nitrogen content increases, phosphoric acid becomes less, and in tankage containing over 5 per cent of nitrogen there is generally less than 15 per cent of phosphoric acid, indicating a preponderance of meat. According to definitions established for tankage to be used for feeding purposes, phosphoric acid in excess of 10 per cent is regarded as bone and meat tankage.

Fineness is an important factor in determining the utilization of tankage by crops, particularly in those products containing the higher amounts of bone.

Eighteen samples have been analyzed and analyses are given in Table XII.

Sample **171** was drawn to check the results obtained on **23142**. Sample **23021** was sold direct to the user and was reinforced with bone phosphate at the direction of the purchaser.

On the basis of the classification suggested above there are six samples in which the nitrogen is less than 5 per cent and the phosphoric acid more than 15 per cent; in the remaining twelve the reverse is true, i. e., nitrogen is more than 5 per cent and phosphoric acid is less than 15 per cent. In the first group the average nitrogen is 4.14 per cent and the average phosphoric acid is 19.86 per cent, which approaches the composition of bone. The average of quoted prices is $34.79.

In the second group the averages for nitrogen and phosphoric acid are 6.62 and 10.35 per cent respectively, and the average price quoted is $46.99.

GROUND BONE.

Twenty-six samples were analyzed and results are given in Table XIII.

The guaranties for nitrogen and phosphoric acid were met in almost all cases, generally with a considerable overage. Two samples which were deficient in phosphoric acid, **23129** and **43**, contained excesses of nitrogen which more than balanced the deficiencies.

In fifteen samples 50 per cent or more of the material was finer than 1/50th of an inch, and in five, 60 per cent or more was of that degree of fineness.

Prices quoted ranged from $36.50 to $66.00, the average being $49.72. The averages for nitrogen and phosphoric acid were 3.42 and 24.16 per cent respectively. *Allowing 27 cents per pound for nitrogen, phosphoric acid from this source has cost 6.5 cents per pound.*

TABLE XI. ANALYSES OF

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.
	Sampled by Station:	
23062	American Agricultural Chemical Co., New York............	Geo. S. Phelps & Co., Thompsonville..................
23259	American Agricultural Chemical Co., New York............	J. P. Norton, Broad Brook....
23017	Apothecaries Hall Co., Waterbury.....................	Sampled at factory, East Windsor.....................
22921	Berkshire Fertilizer Co., Bridgeport.....................	Sampled at factory...........
22961	Berkshire Fertilizer Co., Bridgeport.....................	J. E. Lathrop, Burnside.......
23294	E. D. Chittenden Co., Bridgeport.....................	E. J. Bantle, Glastonbury.....
155	Eastern States Farmers' Exchange, Springfield.........	H. H. McKnight, Ellington....
22963	L. T. Frisbie Co., New Haven..	T. J. Coleman, Warehouse Point
23262	L. T. Frisbie Co., New Haven..	Sampled at factory...........
138	International Agricultural Corp., Boston..................	Chas. Maag, Manchester......
23418	Nitrate Agencies Co., New York	E. N. Austin, Suffield.........
40	Olds & Whipple, Inc., Hartford	Sampled at factory...........
23426	The Rogers & Hubbard Co., Portland.................	" " ....
22987	Sanderson Fertilizer & Chemical Co., New Haven..........	" " ....
23187	Wilcox Fertilizer Co., Mystic..	F. S. Bidwell & Co., Windsor Locks....................
	Sampled by Purchaser:	
21890	Berkshire Fertilizer Co., Bridgeport.....................	American Sumatra Tobacco Co., Bloomfield................
21891	" "	" "
21892	" "	" "
21893	" "	" "
21896	" "	" "
21897	" "	" "
21898	" "	" "
21923	" "	Hatheway & Steane, Hartford..
21924	" "	Hatheway & Steane, Hartford..
21987	" "	American Sumatra Tobacco Co., Bloomfield................
21988	" "	" "
21989	" "	" "
21990	" "	" "
21991	" "	" "
22198	" "	Hatheway & Steane, Hartford..

DRY GROUND FISH.

Nitrogen.				Ammonia equivalent to total nitrogen.	Phosphoric Acid.		
As ammonia.	As organic.	Total found.	Total guaranteed.		Total found.	Total guaranteed.	Station No.
%	%	%	%	%	%	%	
1.29	6.51	7.80	8.23	9.48	9.73	6.00	23062
0.27	8.01	8.28	8.23	10.07	9.20	6.00	23259
1.03	8.02	9.05	8.20	11.00	7.06	5.50	23017
....	.....	8.21	8.22	9.98	7.88	6.00	22921
0.19	7.98	8.17	8.22	9.93	7.93	6.00	22961
0.23	9.05	9.28	8.22	11.28	7.70	4.00	23294
0.83	7.43	8.26	8.23	10.04	5.70	.....	155
0.32	7.68	8.00	8.22	9.73	8.79	6.40	22963
0.39	7.89	8.28	8.22	10.07	7.93	6.40	23262
0.19	6.49	6.68	6.58	8.12	7.03	7.00	138
0.59	8.25	8.84	9.04	10.75	5.25	5.03	23418
0.07	9.35	9.42	8.23	11.45	7.80	5.00	40
0.05	9.68	9.73	9.50	11.83	6.95	.....	23426
0.23	8.30	8.53	8.23	10.37	9.42	6.00	22987
0.88	7.99	8.87	9.04	10.78	7.30	6.00	23187
0.15	7.92	8.07	8.23	9.81	7.50	.....	21890
0.07	8.31	8.38	8.23	10.19	7.46	.....	21891
0.07	8.47	8.54	8.23	10.38	7.54	.....	21892
0.13	8.21	8.34	8.23	10.14	7.61	.....	21893
0.14	8.16	8.30	8.23	10.09	7.69	....	21896
0.08	8.34	8.42	8.23	10.24	7.37	....	21897
0.11	8.29	8.40	8.23	10.21	7.46	....	21898
0.11	8.82	8.93	8.23	10.86	7.80	6.00	21923
0.12	8.61	8.73	8.23	10.61	7.77	6.00	21924
....	....	8.31	8.23	10.10	....	....	21987
0.15	8.61	8.76	8.23	10.65	7.22	....	21988
0.11	8.73	8.84	8.23	10.75	6.83	....	21989
0.12	8.37	8.49	8.23	10.32	7.02	....	21990
0.12	8.14	8.26	8.23	10.04	7.60	....	21991
0.13	8.48	8.61	8.23	10.47	7.83	....	22198

TABLE XI. ANALYSES OF

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.
	Sampled by Purchaser:	
22212	Berkshire Fertilizer Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield
22213	" "	" "
22386	" "	" "
22387	" "	" "
22388	" "	" "
22389	" "	" "
22390	" "	" "
22441	" "	" "
22462	" "	" "
22722	New England Fertilizer Co., Boston	W. E. Fiske, Warehouse Point

DRY GROUND FISH—*Concluded.*

Nitrogen.				Ammonia equivalent to total nitrogen.	Phosphoric Acid.		
As ammonia.	As organic.	Total found.	Total guaranteed.		Total found.	Total guaranteed.	Station No.
%	%	%	%	%	%	%	
0.10	8.62	8.72	8.23	10.60	7.51	....	**22212**
0.13	8.52	8.65	8.23	10.52	6.84	....	**22213**
0.14	8.13	8.27	8.23	10.05	6.74	....	**22386**
0.08	7.97	8.05	8.23	9.79	6.79	....	**22387**
0.13	8.11	8.24	8.23	10.02	6.77	....	**22388**
0.12	7.93	8.05	8.23	9.79	6.49	....	**22389**
0.14	8.05	8.19	8.23	9.96	6.56	....	**22390**
0.20	8.36	8.56	8.23	10.41	7.89	....	**22441**
0.16	8.69	8.85	8.23	10.76	7.25	....	**22462**
0.08	7.63	7.71	....	9.37	4.29	....	**22722**

TABLE XII. ANALYSES OF TANKAGE.

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen. As ammonia.	Nitrogen. As organic.	Nitrogen. Total found.	Nitrogen. *Total guaranteed.*	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Found.	Phosphoric Acid. Guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Mechanical Analysis. Coarser than 1-50 inch.	Station No.
	Sampled by Station:		%	%	%	%	%	%	%	%	%	
23009	Apothecaries Hall Co., Waterbury	Knowles-Lombard, Guilford	0.25	8.14	8.39	7.40	10.20	9.04	9.00	47.0	53.0	**23009**
23015	" "	Station agent at factory, East Windsor	0.34	8.21	8.55	7.81	10.40	4.21	3.00	55.5	44.5	**23015**
23185	" "	H. F. Joy, Woodstock	0.13	4.66	4.79	5.75	5.82	18.75	5.00	52.0	48.0	**23185**
22869	Berkshire Fertilizer Co., Bridgeport	T. W. Ryan, Stratford	....	....	7.23	7.40	8.79	10.84	6.86	52.0	48.0	**22869**
22897	The Connecticut Fat Rendering and Fertilizing Corp., New Haven	Station agent at factory	....	....	3.83	3.29	4.66	19.85	22.28	43.0	57.0	**22897**
171	*The Consolidated* Rendering Co., Boston, Mass.	M. E. Cook, Wallingford	0.22	4.92	5.14	4.92	6.25	13.93	14.00	23.0	77.0	**171**
23236	" "	L. T. Frisbie Co., New Haven	0.19	6.93	7.12	7.41	8.66	10.08	9.15	27.0	73.0	**23236**
23238	" "	L. T. Frisbie Co., New Haven	0.25	5.16	5.41	4.92	6.58	12.61	14.00	26.0	74.0	**23238**
341	" "	Chas. E. Lyman Est., Middlefield	0.22	....	4.82	....	5.86	16.25	....	24.0	76.0	**341**
22906	Eastern States Farmers' Exchange, Springfield	H. H. McKnight, Ellington	....	....	5.28	5.75	6.42	14.89	6.85	36.0	64.0	**22906**
23021	The Consolidated Rendering Co., Boston, Mass.	The Lyman Farm, Middlefield	0.17	4.46	4.63	....	5.63	15.86	....	35.5	64.5	**23021**
23150	Nitrate Agencies Co., Bound Brook, N. J.	H. P. Beers, Greens Farms	0.11	7.04	7.15	5.75	8.69	4.06	6.86	59.0	41.0	**23150**
23474	Worcester Rendering Co., Auburn, Mass.	Dayville Coal & Grain Co., Danielson	0.20	5.93	6.13	5.74	7.45	13.70	10.00	34.0	66.0	**23474**

TABLE XII. ANALYSES OF TANKAGE—*Concluded.*

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen. As ammonia.	Nitrogen. As organic.	Nitrogen. Total found.	Nitrogen. Total guaranteed.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Found.	Phosphoric Acid. Guaranteed.	Mechanical Analysis. Finer than 1–50 inch.	Mechanical Analysis. Coarser than 1–50 inch.	Station No.
	Sampled by Purchaser.		%	%	%	%	%	%	%	%	%	
23325	The Consolidated Rendering Co., Boston, Mass.	Walter T. Clark, Norwich	0.26	5.43	5.69	4.92	6.92	11.68	14.00	26.0	74.0	**23325**
23142	The L. T. Frisbie Co., New Haven	Walter T. Clark, Norwich	0.27	5.60	5.87	4.92	7.14	11.69	14.00	26.0	74.0	**23142**
23347	Lederle's Laboratory, Pearl River, N. Y.	O. G. Beard, Shelton	0.45	7.00	7.45	....	9.06	7.48	.....	8.0	92.0	**23347**
23078	....	Nathan Lerner, North Westchester	....	....	3.23	....	3.93	23.80	.....	36.0	64.0	**23078**
23079	....	Nathan Lerner, North Westchester	....	....	3.51	....	4.27	24.65	.....	53.0	47.0	**23079**

TABLE XIII. ANALYSES OF

Station No.	Manufacturer.	Dealer or Purchaser.
	Sampled by Station:	
23065	American Agricultural Chemical Co., New York	W. C. Mansfield, North Haven
23010	Apothecaries Hall Co., Waterbury	Knowles-Lombard Co., Guilford
23224	Armour Fertilizer Works, New York	Collins & Freeman, Branford
23129	Berkshire Fertilizer Co., Bridgeport	C. Buckingham & Co., Southport
23298	The E. D. Chittenden Co., Bridgeport	J. E. Stoddard, Abington
22932	Consolidated Rendering Co., Boston	Geo. S. Phelps & Co., Thompsonville
23247	Consolidated Rendering Co., Boston	John O. Fox & Co., Putnam
22903	Eastern States Farmers' Exchange, Springfield	H. H. McKnight, Ellington
22917	L. T. Frisbie Co., New Haven	Lightbourn & Pond Co., New Haven
166	New England By-Products Corp., Lawrence, Mass.	C. A. Cowles, Plantsville
167	New England By-Products Corp., Lawrence, Mass.	F. L. Wadhams & Sons, Torrington
23152	Nitrate Agencies Co., Bound Brook, N. J.	H. P. Beers, Greens Farms
22940	Olds & Whipple Co., Inc., Hartford	Station agent at factory
22930	The Rogers & Hubbard Co., Portland	Cadwell & Jones, Hartford
23432	The Rogers & Hubbard Co., Portland	Station agent at factory
22929	F. S. Royster Guano Co., Baltimore	F. B. Newton Estate, Plainville
23448	Sanderson Fertilizer & Chemical Co., New Haven	F. Hallock & Co., Derby
22937	M. L. Shoemaker & Co., Philadelphia	Olds & Whipple, Inc., Hartford
23461	M. L. Shoemaker & Co., Philadelphia	Spencer Bros., Suffield
23191	Virginia-Carolina Chemical Co., New York	E. O. Chapman, North Haven
160	Wilcox Fertilizer Co., Mystic	M. E. Thompson, Ellington
	Sampled by Purchaser:	
22203	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Hartford
22204	" "	Hatheway & Steane, Hartford
22794	" "	E. F. Clark, Woodbury
43	" "	Geo. W. Fraser, Willimantic
23145	L. T. Frisbie & Co., New Haven	Walter T. Clark, Norwich

GROUND BONE.

Nitrogen.		Ammonia equivalent to total nitrogen.	Phosphoric Acid.		Mechanical Analysis.		Station No.
Found.	Guaranteed.		Found.	Guaranteed.	Finer than 1-50 inch.	Coarser than 1-50 inch.	
%	%	%	%	%	%	%	
2.91	2.47	3.54	25.05	22.88	32.0	68.0	**23065**
4.01	3.29	4.88	22.34	20.00	53.5	46.5	**23010**
2.65	2.47	3.22	23.85	22.00	50.0	50.0	**23224**
3.47	1.64	4.22	20.36	25.00	42.0	58.0	**23129**
2.69	2.47	3.27	24.55	22.00	51.0	49.0	**23298**
2.05	2.05	2.49	28.91	26.00	51.0	49.0	**22932**
3.19	2.46	3.88	24.15	24.00	38.0	62.0	**23247**
2.66	2.46	3.23	25.25	23.00	45.0	55.0	**22903**
3.61	2.46	4.39	23.53	20.00	48.0	52.0	**22917**
3.94	3.75	4.79	26.10	25.00	79.5	20.5	**166**
2.02	2.00	2.46	28.40	25.17	54.0	46.0	**167**
2.93	2.46	3.56	24.45	22.88	63.0	37.0	**23152**
2.47	2.50	3.00	26.30	22.00	54.0	46.0	**22940**
3.84	3.82	4.67	26.10	24.70	64.0	36.0	**22930**
4.13	3.29	5.02	22.53	20.50	70.0	30.0	**23432**
2.47	2.47	3.00	27.76	22.90	56.0	44.0	**22929**
2.49	2.47	3.03	26.20	22.88	38.0	62.0	**23446**
4.64	4.51	5.64	23.31	20.00	34.0	66.0	**22937**
5.45	3.69	6.63	21.00	21.00	25.0	75.0	**23461**
4.56	3.70	5.54	20.98	20.60	50.0	50.0	**23191**
2.50	2.46	3.04	22.95	22.80	77.5	22.5	**160**
3.55	....	4.32	24.76	.....	58.0	42.0	**22203**
3.65	....	4.44	24.66	.....	55.0	45.0	**22204**
4.99	....	6.07	22.29	.....	....	....	**22794**
4.65	2.46	5.65	17.62	22.00	44.0	56.0	**43**
3.29	2.46	4.00	24.85	20.00	38.0	62.0	**23145**

VI. MIXED FERTILIZERS.

MIXTURES CONTAINING PHOSPHORIC ACID AND POTASH.

Two samples in which only phosphoric acid and potash were guaranteed were analyzed.

96. Buffalo Phosphate and Potash. International Agricultural Corporation, Boston.

19. Olds and Whipple Bone Phosphate and Potash Compound. Olds and Whipple, Inc., Hartford.

Both samples were drawn by the Station agent. Analyses are as follows:

Station No.	96 %	19 %
Phosphoric acid:		
available, found	12.01	5.22
guaranteed	12.00	4.00
total, found	12.64	5.30
guaranteed	13.00	4.00
Potash:		
found	6.16	16.26
guaranteed	6.00	15.00

MIXTURES CONTAINING NITROGEN AND PHOSPHORIC ACID.

Three samples which contain no potash have been analyzed.

36. Olds and Whipple Top Dressing for Grass, 7-4-0. Sampled by Station agent from stock of F. T. Blish Hardware Co., South Manchester.

23198. Olds and Whipple High Grade Tobacco Starter. Olds and Whipple, Inc., Hartford. Sampled by Station agent from stock of E. O. Gates, Pine Meadow.

23061. Shoemaker's Swift-Sure Tobacco Starter, 4-10-0. Sampled by Station agent from stock of F. S. Bidwell & Co., Windsor Locks.

Analyses are as follows:

Station No.	36 %	23198 %	23061 %
Nitrogen:			
found	5.81	11.15	3.63
guaranteed	5.76	8.23	3.28
Ammonia equivalent to nitrogen found	7.06	13.56	4.41
Phosphoric acid:			
total	7.40	4.30	14.50
available, found	5.15	3.87	10.50
guaranteed	4.00	3.00	10.00

In both these samples the active insoluble organic nitrogen was of good quality as judged by the usual methods.

MIXTURES CONTAINING AMMONIA, PHOSPHORIC ACID AND POTASH.

In Table XIV are given analyses of two hundred and ninety-nine samples of complete fertilizers. Two hundred and eighty-two were drawn officially by the Station agent and seventeen were submitted by purchasers.

In the column headed "grade" appear the figures which represent the guaranteed amounts of ammonia, available phosphoric acid and potash in the order named; thus, 4-8-4 means that the brand is guaranteed to contain 4 per cent of ammonia, 8 per cent of available phosphoric acid and 4 per cent of potash. In the analyses on the right hand pages of the table the corresponding percentages of these constituents as found appear in bold face type.

Concerning Guaranties.

Of the two hundred and eighty-two official samples, one hundred and twenty, or about 40 per cent, failed to completely satisfy their guaranties, deficiencies of 0.12 per cent in ammonia, 0.2 per cent in available phosphoric acid and 0.15 per cent in potash being disregarded. Each sample requires three major determinations in order to check the guaranty, hence eight hundred and forty-six determinations have been required for the official samples in this group. Since some samples have been deficient in more than one item, the total number of deficiencies found was one hundred and forty-nine; in other words, about 82.4 per cent of the individual items of plant food guaranteed have been substantially correct or in excess of guaranties.

Taking the total number of samples of each manufacturer who registered three or more brands, and calculating from the analyses the average shortage or overrun in elements of plant food guaranteed, we deduce the following summary:

Of 26 manufacturers,—

16 equaled or exceeded guaranties in the three elements.

9 equaled or exceeded guaranties in two elements and were short in one.

1 equaled or exceeded the guaranty in one element and was short in two.

Nine of the shortages were in ammonia and there was one each in available phosphoric acid and potash. The ammonia deficiencies ranged from 0.10 to 0.53 per cent; seven were less than 0.25 per cent. The deficiencies in available phosphoric acid and potash were 0.15 and 0.19 per cent respectively.

ANALYSES REQUIRING SPECIAL COMMENT.

Special comment or explanation is due in connection with the following analyses:

185. Aben Hardware Co. This sample represents a part of a cargo of fertilizer salvaged from a wrecked vessel. The goods were found to be under guaranty but they were sold for a price at which the purchaser suffered no loss.

158. Am. Agr. Chem. Co., 3-8-4. The manufacturer obtained 3.74 per cent of potash on a duplicate portion of our sample. Our report for potash was 3.71 per cent. On **159,** 5-8-7 of the same manufacturer, their result for potash was 6.71 per cent; our report was 6.50 per cent.

Five of the Armour brands have shown considerable deficiencies. Second samples were analyzed in nearly all cases.

23398. Atlantic Tobacco Manure 5-8-6. This was found below guaranty in ammonia; a second sample, **172,** from another source, was also low. The results for the two samples were 4.44 and 4.77 respectively.

23125. Berkshire Complete Tobacco 5-3-5. This showed 4.83 per cent ammonia but a second sample, **5,** from another source showed 5.22 per cent. The average analysis for the two samples is 5.03-3.89-5.78, which meets the guaranty.

23301. This sample was drawn as Chittenden's Top Dresser 6-8-4, but analysis showed it to be a 4-8-4 brand. Investigation was made but it could not be determined beyond doubt whether Potato Manure was packed in bags marked "Top Dresser" or whether an error in sampling had occurred. A second sample could not be obtained from this or any other purchaser and the sample is, therefore, accepted as a 4-8-4 brand.

23392. Clark's Special Mixture, 4-8-4, was reported low in ammonia and potash, but a second sample, **299,** was found to meet the guaranty. The average of the two analyses is 3.78-8.69-3.99 which satisfies the guaranty, except in ammonia, and shows no significant deficiency in money value.

23038. Frisbie's Special 3-8-4, was reported low in total phosphoric acid; a second sample, **23305,** was below guaranty in total phosphoric acid and in potash. Available phosphoric acid was satisfactory in both cases. The average for the two samples is 2.94-8.17-3.82.

22992. Frisbie's 4-8-4 was reported low in ammonia and potash; the second sample, **23274,** was likewise deficient. The average for the two analyses is 3.76-8.51-3.73.

22990. Frisbie's 5-8-7 was low in ammonia, and the second sample, **23273,** was deficient in ammonia and potash. The average of the two analyses was 4.70-8.85-6.79.

22984. Frisbie's 7-5-4 was reported low in ammonia, and the second sample, **162,** was also below guaranty in this respect. The average of both analyses is 6.52-5.65-4.10.

23037. Lowell 5-8-7, and **23041,** Lowell 4-8-4. These two samples were found to be below guaranty in ammonia. Portions of our samples were submitted to the manufacturer and the check results were in close agreement with our figures.

23243. Lowell Tobacco 5-4-5 was found low in ammonia but the second sample, **8,** was not deficient. The average of two analyses is 4.87-5.05-5.26.

23154. Naco Brand 2-8-2. This brand is called 2-8-2 but its actual guaranty is 2.8-11.3-2.8, the idea being that the purchaser is to understand that a pound of this brand will contain the same amount of plant food as one and 2/5 pounds of a 2-8-2 grade. Several other brands of the Nitrate Agencies goods are listed on this "equivalent" plan. Registrations, however, should declare the percentage amounts of elements in the goods as sold. To have the brand indicate one grade and the analysis another leads only to confusion.

23060. Royster's Top Dresser 7-6-5 was found to be low in ammonia. Analysis of a duplicate portion of our sample by the manufacturer confirmed our result.

23189. Virginia-Carolina 4-8-6; **23193,** 3-9-5; and **92,** 8-6-6. Duplicate portions of our samples were sent to the manufacturer and their results were in substantial accord with ours in all cases.

The Rogers and Hubbard Co. advise us that very discordant results for available phosphoric acid have been reported to them by control and by commercial laboratories on their bone-base goods. In this connection it should be noted that so-called "available" phosphoric acid is largely influenced by the method of determining citrate-insoluble phosphoric acid, which method was devised for use upon acid phosphate and which does not accurately evaluate phosphoric acid from other sources such as bone, tankage, etc.

Deficiencies in Money Value.

In eighteen brands deficiencies have amounted to more than a dollar per ton, the values being arrived at by balancing overruns against shortages and reckoning ammonia at 21 cents per pound and available phosphoric acid and potash each at 4 cents per pound. Where more than one sample of a given brand has been analyzed the commercial shortage has been estimated on the basis of the average of the analyses made. The brands thus found deficient are listed in Table XV.

TABLE XV. DEFICIENT BRANDS, 1924.

No.	Brand.	Approximate deficiency in money value per ton
159	A. A. C. Co.'s Patapsco 5-8-7	$1.06
23350, 662	Armour's Big Crop 3-8-4	1.63[1]
23315, 661	Armour's Big Crop 4-6-10	1.40[1]
23358, 173	Armour's Big Crop 5-8-5	1.24[1]
23312, 664	Armour's Big Crop 5-8-7	1.90[1]
23318, 665	Armour's Big Crop 8-6-6	7.84[1]
23398, 172	Atlantic Tobacco Manure 5-8-6	1.17[1]
23335	Bowker's Market Garden Fertilizer	1.39
23357	Bowker's Stockbridge Potato and Vegetable Manure	1.14
22900, 302, 307	Eastern States 7-8-3 No-Filler	4.50[2]
22984, 162	Frisbie's Top Dresser 7-5-4	1.41[1]
23071	Godfrey's Potato Manure 4-8-5	2.44
137, 669	I. A. C. Double Strength Fertilizer 10-8-10	2.60[1]
23435	Nitrate Agencies Naco Brand 5-8-7	2.11
23429	Nitrate Agencies Naco Equivalent 5-8-7	1.63
23060	Royster's Top Dresser	3.13
23468	Royster's Wrapper Brand	2.21
92, 666	Virginia-Carolina Tip Top Brand	2.20[1]

The products of a given manufacturer are more adequately judged on the record over a period of years than on the results of a single inspection. If the data given in Table XV is combined with similar data for the preceding three years and compared with the total number of samples of each manufacturer's goods analyzed in this four-year period, we find that of approximately one thousand samples, about one hundred have shown deficiencies in money value of more than $1.00 per ton. In other words, purchasers have obtained commercial values substantially equal to guaranties, or in excess of the same, in about 90 per cent of the purchases represented. This is shown in more detail in the accompanying tabulation, Table XVI. A manufacturer's name does not appear unless ten or more official samples have been analyzed in the four-year period, and the figures refer to individual samples and not to averages.

[1] Based on average of two analyses.
[2] Based on average of three analyses.

TABLE XVI. COMMERCIAL DEFICIENCIES 1921-1924 INCLUSIVE.

Manufacturer.	Total number of samples.	Number of samples substantially equaling or exceeding guaranty in money value.
American Agricultural Chemical Co.	188	177
Apothecaries Hall Co.	28	28
Armour Fertilizer Works	47	32
Atlantic Packing Co.	30	26
Berkshire Fertilizer Co.	32	32
Bowker Fertilizer Co.	57	50
The E. D. Chittenden Co.	26	25
E. B. Clark Seed Co.	18	16
The Coe-Mortimer Co.	30	27
Eastern States Farmers' Exchange	39	32
Essex Fertilizer Co.	31	30
L. T. Frisbie Co.	48	38
International Agricultural Corp.	33	29
Lowell Fertilizer Co.	42	35
Mapes Fertilizer and Peruvian Guano Co.	53	52
New England Fertilizer Co.	33	30
Nitrate Agencies Co.	14	11
Olds & Whipple, Inc.	23	23
Parmenter & Polsey Fertilizer Co.	16	15
The Rogers & Hubbard Co.	53	51
F. S. Royster Guano Co.	30	21
Sanderson Fertilizer & Chemical Co.	34	32
M. L. Shoemaker & Co.	11	11
Springfield Rendering Co.	18	16
Virginia-Carolina Chemical Co.	38	35
Wilcox Fertilizer Co.	31	28
Total	1003	902

CLASSIFICATION OF GRADES WITH REFERENCE TO AMMONIA.

About 70 per cent of the two hundred and eighty-two samples examined have carried guaranties of ammonia of 4 per cent or over. A tabulation for the last four years shows the distribution of ammonia grades and indicates a decrease in the proportion of low nitrogen goods.

Guaranty.	Percentage of Samples. 1921	1922	1923	1924
1 per cent ammonia (0.82 nitrogen)	10.0	6.0	4.2	2.1
2 per cent ammonia (1.65 nitrogen)	20.4	19.1	16.5	12.8
3 per cent ammonia (2.47 nitrogen)	23.2	19.1	16.1	14.9
4 per cent ammonia (3.29 nitrogen)	20.4	25.9	26.1	24.8
5 per cent ammonia (4.11 nitrogen)	21.4	23.0	24.5	27.0
6 per cent ammonia (4.94 nitrogen)	4.6	6.9	4.9	6.7
7 per cent and over (5.76 or more)	....	....	7.7	11.7
Total	100.0	100.0	100.0	100.0

THE "NEW ENGLAND STANDARD NINE."

The number of grades represented by the two hundred and eighty-two samples of complete fertilizers and two of the group containing potash and phosphoric acid only is seventy-four. The number of samples falling in the "Standard Nine" grades is ninety-six; but, if several grades closely corresponding to these are included, the number is increased to one hundred and twenty-seven. What proportion of the total tonnage in this State is represented by the "Standard Nine" cannot be stated at this time. Less than one-half of the samples examined have fallen in the selected grades or those closely corresponding thereto.

In the following summary the "Standard Nine" grades are indicated in full face type.

Grade.	Number of samples.
0-12-6	1
2-12-4	2
3-10-3	5
3-10-4	4
3-10-6	0
4-7-5	1
4-8-4	34
4-8-5	2
4-8-6	9
4-8-7	11
5-4-4	1
5-4-5	25
5-8-6	6
5-8-7	22
8-6-6	4
Total	127

QUALITY OF THE NITROGEN IN MIXED FERTILIZERS.

The nitrogen derived from nitrates and from ammonium salts is soluble in water and its utilization by plants is relatively rapid and complete. A portion of the organic nitrogen may also be soluble in water and this is presumably more readily utilized by plants than that portion which is insoluble. For many years it has been the practice of agricultural chemists to evaluate approximately the insoluble organic nitrogen of fertilizers. Two methods are employed for this purpose, both of which depend upon the action of dilute solutions of permanganate of potash upon the nitrogenous material under examination, the one an alkaline solution, the other a neutral solution. The results do not measure the availability of the insoluble nitrogen in the generally accepted sense of that term, but they parallel vegetation tests to the extent that low activity values indicate forms of nitrogen which show poor crop-producing power.

In judging the quality of the insoluble nitrogen it is our practice to apply the alkaline permanganate method in all cases where the amount of the insoluble exceeds 3/10 of one per cent. If less than 50 per cent activity is shown, the neutral method is used, check determinations being made in both cases. Activity values of less than 50 per cent by the alkaline method and less than 80 per cent by the neutral method are interpreted as indicating inferior forms of nitrogenous material.

Four samples this year showed results for active insoluble nitrogen less than the limits just quoted. In two of them the actual amounts of insoluble nitrogen were small (0.3 to 0.4), constituting only about 1/10 and 1/4 respectively of the total nitrogen, and judgment was suspended. In Super-Alphano (**127**) and Woodruff's Home Mixture (**23188**), the insoluble nitrogen constituted 3/5 and 2/5 respectively of the total, and the activity figures were 44.4 and 41.8 per cent respectively by the alkaline method and 55 and 74.2 per cent respectively by the neutral method.

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Aben Hardware Co., New London.**		
185	5-10-5 Fertilizer	5-10-5	Poquonock Bridge.
	American Agricultural Chemical Co., New York.		
23382	Agrico Tobacco Manure	7-3-7	Unionville
23263	Complete Potato Mixture	3-8-4	North Haven
23353	Double A Tobacco Fertilizer	5-4-5	New Milford
23261	Fish and Potash	3-10-3	Thompsonville
23354	Grass and Lawn Top Dressing	6-6-4	Farmington
23066	7% Potash Fertilizer	4-8-7	New Britain
23356	Tobacco Fertilizer, 5-4-3	5-4-3	Glastonbury
23268	Universal Phosphate	1-8-2	Norfolk
23376	Bradley's Complete Manure for Poatoes and Vegetables	4-8-7	Stamford
23373	Bradley's Complete Tobacco Manure	5-4-5	Glastonbury
23266	Bradley's Corn Phosphate	2-8-2	Stamford
23264	Bradley's New Method Fertilizer	1-8-2	Meriden
23267	Bradley's Potato Fertilizer	2-8-3	Bethel
23375	Bradley's Potato Manure	3-6-4	Meriden
23374	Bradley's Superior Tobacco Compound	7-3-7	Glastonbury
309	Bradley's Superior Tobacco Compound	7-3-7	Broad Brook
23371	Bradley's XL Superphosphate of Lime	3-9-2	Suffield
23471	National Complete Tobacco Fertilizer	5-4-5	Warehouse Point
23478	National Market Garden Fertilizer	3-8-4	Greenwich
23472	National Potato and Corn Phosphate	2-8-3	Warehouse Point
23480	National Premier Truck Manure	4-8-7	Silver Lane
23470	National White Ash Tobacco Grower	7-3-7	Warehouse Point
23477	National XXX Fish and Potash	3-10-3	Broad Brook
159	Patapsco, 5-8-7	5-8-7	Norwich
158	Patapsco General Truck Fertilizer	3-8-4	Mansfield Center
152	Patapsco Matchless Potash Manure	2-8-2	Putnam
23372	Patapsco Peerless Potato Guano	4-8-4	Guilford
23381	Quinnipiac Corn Manure	2-8-2	Farmington
23378	Quinnipiac Market Garden Manure	4-8-7	Gaylordsville
23380	Quinnipiac Potato Phosphate	2-8-3	Farmington
23377	Quinnipiac Prime Tobacco Manure	7-3-7	Manchester

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH.

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
1.50	1.27	0.30	0.91	3.98	**4.84**	0.48	10.18	**9.70**	5.01	**5.01**	**185**
1.08	0.09	0.27	4.28	5.72	**6.95**	0.33	3.98	**3.65**	0.62	**8.07**	**23382**
0.60	0.79	0.42	0.61	2.42	**2.94**	0.58	8.90	**8.32**	4.08	**4.08**	**23263**
0.92	0.06	0.11	2.98	4.07	**4.95**	0.28	4.80	**4.52**	0.40	**5.00**	**23353**
0.60	0.79	0.49	0.59	2.47	**3.00**	0.77	10.75	**9.98**	3.02	**3.02**	**23261**
2.21	1.25	0.75	0.62	4.83	**5.87**	0.60	7.23	**6.63**	4.00	**4.00**	**23354**
0.64	1.27	0.83	0.57	3.31	**4.02**	1.07	8.90	**7.83**	6.94	**6.94**	**23066**
0.94	0.01	0.18	3.01	4.14	**5.03**	0.35	4.58	**4.23**	0.44	**3.16**	**23356**
0.12	0.32	0.33	0.52	1.29	**1.57**	0.69	8.89	**8.20**	2.24	**2.24**	**23268**
0.65	1.28	0.86	0.49	3.28	**3.99**	1.19	8.96	**7.77**	7.10	**7.10**	**23376**
0.75	0.08	0.16	3.10	4.09	**4.97**	0.25	4.60	**4.35**	0.47	**5.11**	**23373**
0.11	0.46	0.71	0.48	1.76	**2.14**	0.65	8.75	**8.10**	2.23	**2.23**	**23266**
0.20	0.37	0.27	0.60	1.44	**1.75**	0.68	8.88	**8.20**	2.28	**2.28**	**23264**
0.12	0.54	0.55	0.54	1.75	**2.13**	0.85	9.03	**8.18**	3.14	**3.14**	**23267**
0.58	0.81	0.51	0.54	2.44	**2.97**	0.46	8.53	**8.07**	4.27	**4.27**	**23375**
0.88	0.12	0.32	4.26	5.58	**6.78**	0.28	4.08	**3.80**	0.58	**7.41**	**23374**
....	....	....	....	5.58	**6.76**	0.45	3.90	**3.45**	0.51	**6.55**	**309**
0.65	0.74	0.66	0.71	2.76	**3.36**	0.75	10.55	**9.80**	2.57	**2.57**	**23371**
1.04	0.00	0.00	2.94	3.98	**4.84**	0.28	4.65	**4.37**	0.53	**5.30**	**23471**
0.64	0.96	0.77	0.47	2.84	**3.45**	0.73	8.94	**8.21**	3.61	**3 61**	**23478**
0.21	0.52	0.53	0.53	1.79	**2.18**	0.96	8.83	**7.87**	3.18	**3.18**	**23472**
0.80	1.21	0.86	0.47	3.34	**4.06**	1.05	9.23	**8.18**	6.33	**6.33**	**23480**
1.11	0.04	0.10	4.25	5.50	**6.69**	0.30	3.90	**3.60**	0.56	**7.80**	**23470**
0.59	0.76	0.49	0.56	2.40	**2.92**	0.74	10.61	**9.87**	2.96	**2.96**	**23477**
0.87	1.87	0.63	0.63	4.00	**4.86**	0.67	8.57	**7.90**	6.50	**6.50**	**159**
0.57	0.78	0.61	0.44	2.40	**2.92**	0.40	8.32	**7.92**	3.71	**3.71**	**158**
0.02	0.55	0.66	0.55	1.78	**2.16**	0.60	8.85	**8.25**	1.94	**1.94**	**152**
0.78	1.23	0.66	0.56	3.23	**3.93**	1.03	9.02	**7.99**	3.86	**3.86**	**23372**
0.10	0.45	0.56	0.54	1.65	**2.01**	0.58	8.88	**8.30**	2.03	**2.03**	**23381**
0.61	1.31	0.87	0.54	3.33	**4.05**	1.09	8.97	**7.88**	6.66	**6.66**	**23378**
0.00	0.54	0.59	0.54	1.67	**2.03**	0.85	9.10	**8.25**	3.25	**3.25**	**23380**
0.95	0.13	0.22	4.22	5.52	**6.71**	0.45	4.13	**3.68**	0.54	**7.81**	**23377**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station:		
	American Agricultural Chemical Co., New York.—*Continued*		
310	Quinnipiac Prime Tobacco Manure	7-3-7	Buckland.........
23379	Quinnipiac Seed Leaf Tobacco Manure....................	5-4-5	Gaylordsville......
23479	Wheeler's Corn Fertilizer.........	2-8-2	Plainville.........
18	Wheeler's Cuban Tobacco Grower	5-4-5	New Milford......
17	Wheeler's Potato Manure........	2-8-3	Shelton..........
	Apothecaries Hall Co., Waterbury.		
23216	Liberty, 2-8-2..................	2-8-2	East Windsor.....
23186	Liberty Corn, Fruit and All Crops	2-12-4	Woodstock.......
22995	Liberty Fish Bone and Potash....	3-10-4	Meriden ....
23310	Liberty Fish Bone and Potash....	3-10-4	Branford.........
22996	Liberty High Grade Market Gardeners.....................	5-8-7	Meriden ....
23321	Liberty High Grade Tobacco Manure......................	8-4-5	East Windsor.....
23183	Liberty Market Gardener's Special	4-8-4	Guilford..........
23313	Liberty Tobacco Special..........	5-4-5	Middletown......
23314	Liberty Top Dresser for Grass and Grain.......................	10-3.5-8	Middletown......
	Armour Fertilizer Works, New York.		
23350	Armour's Big Crop, 3-8-4.........	3-8-4	Danbury.........
662	Armour's Big Crop, 3-8-4.........	3-8-4	New Haven......
23315	Armour's Big Crop, 4-6-10........	4-6-10	Madison.........
661	Armour's Big Crop, 4-6-10........	4-6-10	New Haven......
23311	Armour's Big Crop, 4-8-4.........	4-8-4	Branford.........
663	Armour's Big Crop, 4-8-4.........	4-8-4	Danbury.........
23358	Armour's Big Crop, 5-8-5.........	5-8-5	Milford..........
173	Armour's Big Crop, 5-8-5.........	5-8-5	Milford..........
23312	Armour's Big Crop, 5-8-7.........	5-8-7	Guilford..........
664	Armour's Big Crop, 5-8-7.........	5-8-7	Madison.........
23318	Armour's Big Crop, 8-6-6........	8-6-6	Wallingford.......
665	Armour's Big Crop, 8-6-6.........	8-6-6	New London......
23014	Armour's Big Crop Tobacco Special	5-4-5	Danbury.........
169	Armour's Big Crop Tobacco Special	5-4-5	Danbury.........
23349	Armour's Corn Grower, 2-8-2.....	2-8-2	New Canaan......

Containing Nitrogen, Phosphoric Acid and Potash—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
....	....	....	....	5.81	**7.06**	0.30	3.85	**3.55**	0.51	**7.12**	**310**
0.68	0.07	0.16	3.14	4.05	**4.92**	0.28	4.33	**4.05**	0.39	**5.58**	**23379**
0.05	0.46	0.68	0.56	1.75	**2.13**	0.95	9.00	**8.05**	2.12	**2.12**	**23479**
0.87	0.03	0.15	3.00	4.05	**4.92**	0.25	4.23	**3.98**	0.39	**5.00**	**18**
0.03	0.50	0.66	0.49	1.68	**2.04**	0.85	9.08	**8.23**	3.01	**3.01**	**17**
1.01	-0.14	0.48	0.78	2.41	**2.93**	1.75	10.28	**8.53**	2.26	**2.26**	**23216**
0.00	1.24	0.40	0.11	1.75	**2.13**	1.01	13.01	**12.00**	4.89	**4.89**	**23186**
0.53	1.63	0.56		2.72	**3.31**	0.78	11.13	**10.35**	4.02	**4.02**	**22995**
0.41	1.65	0.36	0.27	2.69	**3.27**	1.00	11.18	**10.18**	4.06	**4.06**	**23310**
1.05	2.90	0.30		4.25	**5.17**	0.49	8.67	**8.18**	7.10	**7.10**	**22996**
0.01	3.19	0.40	3.03	6.63	**8.06**	0.23	6.25	**6.02**	0.64	**6.23**	**23321**
0.80	2.07	0.09	0.35	3.31	**4.02**	0.95	9.10	**8.15**	4.36	**4.36**	**23183**
0.02	1.27	0.37	2.43	4.09	**4.97**	0.25	5.33	**5.08**	0.58	**7.65**	**23313**
4.69	3.00	0.51	0.52	8.72	**10.60**	1.03	6.35	**5.32**	9.63	**9.63**	**23314**
0.23	0.47	0.34	0.78	1.82	**2.21**	0.61	8.53	**7.92**	4.95	**4.95**	**23350**
....	....	....	....	2.50	**3.04**	0.40	7.55	**7.05**	....	**3.86**	**662**
2.25	0.37	0.42	0.58	3.62	**4.40**	0.40	6.26	**5.86**	9.43	**9.43**	**23315**
....	....	....	....	2.78	**3.38**	0.36	6.08	**5.72**	....	**6.64**	**661**
0.53	1.22	0.44	1.15	3.34	**4.06**	0.73	8.47	**7.74**	4.54	**4.54**	**23311**
....	....	....	....	3.05	**3.71**	1.38	9.43	**8.05**	....	**4.21**	**663**
0.83	1.08	0.51	1.05	3.47	**4.22**	0.61	8.68	**8.07**	6.50	**6.50**	**23358**
....	....	....	....	3.84	**4.67**	0.59	8.20	**7.61**	....	**6.50**	**173**
0.46	1.95	0.40	0.93	3.74	**4.55**	0.68	8.75	**8.07**	6.45	**6.45**	**23312**
....	....	....	....	3.98	**4.84**	0.75	9.83	**9.08**	....	**4.81**	**664**
1.38	1.69	0.50	1.33	4.90	**5.96**	0.55	6.68	**6.13**	8.77	**8.77**	**23318**
....	....	....	....	4.34	**5.28**	0.70	9.43	**8.73**	....	**5.74**	**665**
0.59	0.06	0.16	3.02	3.83	**4.66**	0.54	4.78	**4.24**	0.73	**4.80**	**23014**
....	....	....	....	4.12	**5.01**	0.75	5.20	**4.45**	....	**5.15**	**169**
0.12	0.62	0.32	0.59	1.65	**2.01**	0.88	9.00	**8.12**	2.18	**2.18**	**23349**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station:		
	Atlantic Packing Co., New Haven.		
23337	Atlantic, 4-8-6	**4-8-6**	Cromwell
23331	Atlantic, 5-8-7	**5-8-7**	Manchester
23127	Atlantic Grain Fertilizer, 2-8-2	**2-8-2**	"
23126	Atlantic Potato Phosphate, 3-8-4	**3-8-4**	"
23332	Atlantic Special Vegetable, 4-8-4	**4-8-4**	"
172	Atlantic Tobacco Manure, 5-8-6	**5-8-6**	Glastonbury
23398	Atlantic Tobacco Manure, 5-8-6	**5-8-6**	Cromwell
23391	Atlantic Top Dresser, 7-5-4	**7-5-4**	Manchester
	F. A. Bartlett Tree Expert Co., Stamford.		
300	Bartlett's Green Tree Food	**6-8-4**	Stamford
	Berkshire Fertilizer Co., Bridgeport.		
23214	Berkshire Complete Fertilizer	**3-8-3**	New Canaan
23125	Berkshire Complete Tobacco	**5-3-5**	Windsor Locks
5	Berkshire Complete Tobacco	**5-3-5**	Talcottville
23394	Berkshire Economical Grass Fertilizer	**10-3-8**	Bridgeport
23225	Berkshire Grass Special	**7-2-4**	Windsor Locks
23135	Berkshire Long Island Special	**5-8-7**	Litchfield
23219	Berkshire Market Garden	**4-8-4**	Litchfield
23209	Berkshire Potato and Vegetable Phosphate	**2-8-4**	Branford
23399	Berkshire Tobacco Special	**7-3-5**	Suffield
	F. E. Boardman, Middletown.		
150	Boardman's Complete Fertilizer for Potatoes and General Crops	**4-7-4**	Middletown
156	Boardman's Tobacco Fertilizer	**4-7-4**	Middletown
	Bowker Fertilizer Co., New York.		
23329	Bowker's All Round Fertilizer	**3-8-4**	Meriden
23360	Bowker's *Conn. Valley Tobacco* Fertilizer	**5-4-3**	Hazardville
23232	Bowker's Corn, Grain and Grass Phosphate	**2-8-2**	Colchester
23333	Bowker's Fisherman's Fish and Potash	**3-10-3**	Meriden
23335	Bowker's Market Garden Fertilizer	**4-8-4**	Colchester
23229	Bowker's Potato and Vegetable Phosphate	**2-8-3**	Meriden
23336	Bowker's Square Brand Farm and Garden Phosphate	**2-8-2**	Unionville

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen. In nitrates.	Nitrogen. In ammonia.	Nitrogen. Organic, water-soluble.	Nitrogen. Organic, water-insoluble.	Nitrogen. Total.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So-called "Available."	Potash. As muriate.	Potash. Total.	Station No.
%	%	%	%	%	%	%	%	%	%	%	
0.94	0.93	0.61	0.95	3.43	4.17	0.58	9.45	8.87	6.14	6.14	23337
1.52	0.85	0.67	1.00	4.04	4.91	0.68	9.40	8.72	7.24	7.24	23331
0.06	0.83	0.35	0.41	1.65	2.01	0.38	8.34	7.96	2.17	2.17	23127
0.00	*1.40*	*0.44*	0.57	2.41	2.93	*0.60*	8.79	8.19	3.99	3.99	23126
0.97	0.79	0.56	0.82	3.14	3.82	0.48	9.00	8.52	4.40	4.40	23332
1.11	0.70	0.77	1.34	3.92	4.77	0.60	9.20	8.60	1.02	6.08	172
1.23	0.56	0.62	1.24	3.65	4.44	0.78	9.00	8.22	0.94	6.26	23398
2.41	1.48	0.92	0.80	5.61	6.82	0.40	5.95	5.55	4.34	4.34	23391
....	....	....	....	5.06	6.15	2.49	9.31	6.82	4.33	4.33	300
0.92	0.67	0.47	0.61	2.67	3.25	0.83	9.38	8.55	3.81	3.81	23214
0.78	0.17	0.43	2.59	3.97	4.83	0.58	4.35	3.77	0.93	6.12	23125
....	....	....	....	4.29	5.22	0.43	4.43	4.00	....	5.43	5
1.35	5.34	0.53	1.02	8.24	10.02	7.18	11.03	3.85	8.59	8.92	23394
2.86	0.47	0.62	1.73	5.68	6.91	1.85	6.95	5.10	4.26	4.26	23225
1.36	1.31	0.91	0.89	4.47	5.43	1.03	9.30	8.27	7.84	7.84	23135
0.66	1.21	0.79	0.74	3.40	4.13	1.00	9.45	8.45	4.25	4.78	23219
0.50	0.31	0.42	0.52	1.75	2.13	1.13	10.07	8.94	3.59	3.59	23209
1.59	0.12	0.61	3.34	5.66	6.88	0.48	4.35	3.87	1.05	5.91	23399
0.61	0.76	0.67	1.19	3.23	3.93	1.23	8.68	7.45	4.42	4.42	150
0.24	0.97	0.37	1.99	3.57	4.34	0.55	7.88	7.33	1.10	4.93	156
0.58	0.83	0.60	0.50	2.51	3.05	0.55	8.69	8.14	4.33	4.33	23329
0.92	0.07	0.08	3.30	4.37	5.31	0.38	5.05	4.67	0.24	3.13	23360
0.04	0.55	0.56	0.52	1.67	2.03	0.68	8.81	8.13	2.00	2.00	23232
0.60	0.75	0.60	0.58	2.53	3.08	0.67	10.68	10.01	3.04	3.04	23333
0.62	1.27	0.56	0.57	3.02	3.67	0.73	8.85	8.12	3.88	3.88	23335
0.02	0.51	0.58	0.56	1.67	2.03	0.88	9.00	8.12	3.17	3.17	23229
0.09	0.51	0.57	0.58	1.75	2.13	0.85	9.00	8.15	2.22	2.22	23336

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Bowker Fertilizer Co., New York.** —*Continued*		
23319	Bowker's Sure Crop Phosphate....	1-8-2	Willimantic.......
23357	Stockbridge Potato and Vegetable Manure....................	4-6-10	Brooklyn.........
23359	Stockbridge Premier Tobacco Grower....................	7-3-7	South Windsor....
23351	Stockbridge Truck Manure.......	4-8-7	Waterbury.......
23352	Stockbridge Tobacco Manure.....	5-4-5	Suffield..........
23355	Stockbridge Top Dressing and Forcing Manure	6-6-4	Meriden.........
	A. D. Bridges' Sons, Inc., Hazardville.		
23316	Corn, Onion and Potato and General Purpose.............	4-8-4	Hazardville.......
23320	Special Tobacco Fertilizer........	5-3-5	Hazardville. .....
	The E. D. Chittenden Co., Bridgeport.		
23299	Chittenden's Complete Grain.....	2-8-3	Abington.........
668	Chittenden's Complete Grain.....	2-8-3	Glastonbury......
134	Chittenden's Complete Tobacco and Onion Grower............	4-8-4	Somers...........
130	Chittenden's High Grade Tobacco, 7½% Potash................	6.5-3-7.5	Glastonbury......
23293	Chittenden's Potato Special, 4% Potash.....................	4-8-4	Glastonbury......
502	Chittenden's Potato Special, 4% Potash.....................	4-8-4	Abington.........
23301	Chittenden's Potato Special, 4% Potash.....................	4-8-4	Glastonbury......
23217	Chittenden's Potato Special, 6% Potash.....................	4-8-6	Windsor Locks....
129	Chittenden's Tobacco Special, 5% Potash.....................	5-4-5	Windsor Locks....
135	Chittenden's Vegetable and Onion Grower....................	3-8-3	Somers...........
	E. B. Clark Seed Co., Milford.		
23392	Clark's Special Mixture for General Use.......................	4-8-4	Milford..........
299	Clark's Special Mixture for General Use.......................	4-8-4	Milford..........
12	Clark's Special Mixture for General Use.......................	4-10-4	Branford.........

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.01	0.24	0.32	0.27	0.84	**1.02**	0.56	8.15	**7.59**	1.72	**1.72**	**23319**
0.75	1.22	0.41	0.68	3.06	**3.72**	0.55	6.65	**6.10**	9.95	**9.95**	**23357**
1.09	0.08	0.19	4.28	5.64	**6.86**	0.38	4.20	**3.82**	0.53	**7.58**	**23359**
0.67	1.26	0.70	0.53	3.16	**3.84**	0.98	9.00	**8.02**	7.02	**7.02**	**23351**
1.11	0.05	0.01	2.99	4.16	**5.06**	0.28	4.50	**4.22**	0.51	**4.94**	**23352**
2.66	1.22	0.45	0.61	4.94	**6.01**	0.63	7.05	**6.42**	4.47	**4.47**	**23355**
0.88	1.15	0.46	1.21	3.70	**4.50**	0.78	9.35	**8.57**	4.23	**5.21**	**23316**
0.95	0.08	0.12	3.29	4.44	**5.40**	0.35	4.18	**3.83**	0.66	**6.06**	**23320**
0.48	0.41	0.13	0.40	1.42	**1.73**	0.38	8.53	**8.15**	2.99	**2.99**	**23299**
....	....	....	....	1.88	**2.29**	0.68	8.68	**8.00**	....	**3.13**	**668**
0.49	1.85	0.25	0.59	3.18	**3.87**	0.40	8.70	**8.30**	1.01	**4.04**	**134**
0.15	2.54	0.25	2.41	5.35	**6.50**	0.23	5.95	**5.72**	0.70	**7.57**	**130**
0.26	2.03	0.34	0.61	3.24	**3.94**	0.37	8.08	**7.71**	2.39	**4.80**	**23293**
....	....	....	....	3.18	**3.87**	....	8.75	....	....	**5.12**	**502**
....	....	....	....	3.42	**4.16**	....	9.00	....	....	**3.90**	**23301**
0.30	1.48	0.53	0.62	2.93	**3.56**	0.44	8.44	**8.00**	7.49	**7.49**	**23217**
0.11	2.08	0.13	1.43	3.75	**4.56**	0.25	5.23	**4.98**	2.33	**6.77**	**129**
0.87	1.45	0.20	0.60	3.12	**3.79**	0.93	8.93	**8.00**	3.76	**3.76**	**135**
0.57	1.24	0.47	0.60	2.88	3.50	1.18	9.80	**8.62**	3.66	**3.66**	**23392**
....	....	....	....	3.33	**4.05**	0.78	9.53	**8.75**	4.31	**4.31**	**299**
0.00	2.51	0.36	0.56	3.43	**4.17**	0.55	11.28	**10.73**	4.10	**4.10**	**12**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **E. B. Clark Seed Co., Milford.**—*Continued*		
23389	Clark's Special Potash Mixture, 4-8-6	4-8-6	Milford
11	Clark's Tip Top Brand, 4-8-4	4-8-4	Branford
23390	Clark's Tip Top Brand, 5-8-5	5-8-5	Milford
	The Coe-Mortimer Co., New York.		
23231	E. Frank Coe's Celebrated Special Potato Fertilizer	4-8-4	Colchester
23230	E. Frank Coe's Columbian Corn and Potato Fertilizer	2-8-3	Saybrook
23340	E. Frank Coe's Connecticut Wrapper Grower	5-4-5	Suffield
23132	E. Frank Coe's Gold Brand Excelsior Guano	3-8-4	New Canaan
23226	E. Frank Coe's New Englander Special	1-8-2	Bethel
23136	E. Frank Coe's Red Brand Excelsior Guano	4-8-7	Farmington
23334	E. Frank Coe's Special Grass Top Dressing	6-6-4	Colchester
	C. A. Cowles, Plantsville.		
23317	C. A. Cowles', 4-8-4 Fertilizer	4-8-4	Plantsville
	Eastern States Farmers' Exchange, Springfield, Mass.		
22876	Eastern States, 3-12-3 No Filler	3-12-3	South Windsor
306	Eastern States, 3-12-3 No Filler	3-12-3	Ellington
22907	Eastern States, 5-8-7 No Filler	5-8-7	Ellington
314	Eastern States, 5-8-7 No Filler	5-8-7	Farmington
22866	Eastern States, 5-10-5 No Filler	5-10-5	Milford
301	Eastern States, 5-10-5 No Filler	5-10-5	Ellington
22900	Eastern States, 7-8-3 No Filler	7-8-3	South Windsor
302	Eastern States, 7-8-3 No Filler	7-8-3	Ellington
307	Eastern States, 7-8-3 No Filler	7-8-3	Ellington
23044	Eastern States, 4-8-4	4-8-4	Guilford
154	Eastern States, 6-3-5	6-3-5	Ellington
304	Eastern States, 6-3-5	6-3-5	Ellington
22901	Eastern States, 6-3½-7	6-3.5-7	South Windsor
23397	Eastern States, 6¼-3-5	6.25-3-5	Ellington
303	Eastern States, 6¼-3-5	6.25-3-5	"
23396	Eastern States, 7-2-7	7-2-7	"
22908	Eastern States Tobacco Fertilizer, Formula C	6-3-5	"

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.00	1.91	0.60	0.82	3.33	4.05	1.08	9.35	8.27	6.21	6.21	23389
0.13	1.42	0.58	1.19	3.32	4.04	1.53	9.60	8.07	4.83	4.83	11
0.82	1.63	0.81	0.90	4.16	5.06	1.23	9.45	8.22	5.14	5.14	23390
0.94	1.15	0.49	0.63	3.21	3.90	0.81	8.81	8.00	3.92	3.92	23231
0.13	0.45	0.54	0.55	1.67	2.03	0.77	8.83	8.06	3.15	3.15	23230
0.88	0.07	0.00	2.93	3.88	4.72	0.23	4.60	4.37	0.43	5.13	23340
0.59	0.78	0.73	0.47	2.57	3.12	0.46	8.51	8.05	4.31	4.31	23132
0.14	0.31	0.44	0.56	1.45	1.76	0.70	8.90	8.20	2.22	2.22	23226
0.82	1.27	0.64	0.49	3.22	3.91	0.95	8.70	7.75	7.32	7.32	23136
2.78	1.57	0.17	0.55	5.07	6.16	0.95	7.50	6.55	4.43	4.43	23334
0.58	1.59	0.41	0.50	3.08	3.74	0.15	8.28	8.13	4.36	4.36	23317
0.74	0.60	0.48	0.54	2.36	2.87	0.87	12.88	12.01	3.09	3.09	22876
....	....	....	....	2.50	3.04	0.91	12.05	11.14	3.19	3.19	306
2.12	0.77	0.33	0.59	3.81	4.63	0.64	8.83	8.19	6.47	6.64	22907
....	....	....	....	4.17	5.07	0.78	9.20	8.42	6.32	6.32	314
0.85	2.08	0.29	0.75	3.97	4.83	0.65	10.76	10.11	5.00	5.11	22866
....	....	....	....	3.89	4.73	0.92	10.67	9.75	4.85	4.85	301
1.77	1.52	0.31	0.58	4.18	5.08	0.51	8.53	8.02	4.59	4.59	22900
....	....	....	....	4.61	5.60	0.70	9.53	8.83	2.93	2.93	302
....	....	....	....	5.51	6.70	1.65	9.27	7.62	2.22	3.02	307
1.13	1.16	0.36	0.49	3.14	3.82	0.60	9.73	9.13	3.85	3.85	23044
0.59	0.18	0.07	4.06	4.90	5.93	0.33	4.98	4.65	1.05	5.90	154
....	....	....	....	4.42	5.37	0.25	5.25	5.00	1.86	5.82	304
1.56	0.18	0.30	3.46	5.50	6.69	0.43	5.80	5.37	1.02	7.50	22901
0.19	0.94	0.44	3.88	5.45	6.63	0.45	5.33	4.88	1.26	5.46	23397
....	....	....	....	5.05	6.14	0.58	5.25	4.67	1.02	6.12	303
1.38	0.05	0.70	3.37	5.50	6.69	2.50	5.68	3.18	1.25	9.10	23396
0.55	0.28	0.60	3.50	4.93	5.99	0.23	5.35	5.12	1.13	6.36	22908

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station:		
	Essex Fertilizer Co., Boston, Mass.		
20	Essex 2-8-2 for Farm and Garden..	2-8-2	Hartford.........
22	Essex 2-8-3 for All Crops.........	2-8-3	Plainville
15	Essex Fish Fertilizer for all Crops..	3-8-4	South Manchester.
14	Essex Market Garden for Potatoes, Roots and Vegetables..........	4-8-4	South Manchester.
16	Essex 4-6-10 for Potatoes and Vegetables..................	4-6-10	South Manchester.
21	Essex 5-8-7 for Potatoes and Vegetables..................	5-8-7	Hartford.........
13	Essex Potato Phosphate, 4-8-7....	4-8-7	South Manchester.
23	Essex Special Tobacco 5-4-5......	5-4-5	Wapping.........
24	Essex Tobacco Manure, 5-8-6.....	5-8-6	West Suffield......
	L. T. Frisbie Co., New Haven.		
22955	Frisbie's, 4-10-6................	4-10-6	Woodmont.......
22990	Frisbie's, 5-8-7.................	5-8-7	Clintonville.......
23273	Frisbie's, 5-8-7.................	5-8-7	Wethersfield......
23042	Frisbie's Corn and Grain Fertilizer, 2-8-2......................	2-8-2	Danbury.........
23245	Frisbie's Market Garden, 4-8-6....	4-8-6	Torrington.......
23038	Frisbie's Special, 3-8-4..........	3-8-4	North Haven.....
23305	Frisbie's Special, 3-8-4..........	3-8-4	Wallingford.......
22992	Frisbie's Special Potato and Vegetable Grower, 4-8-4...........	4-8-4	Wethersfield......
23274	Frisbie's Special Potato and Vegetable Grower, 4-8-4...........	4-8-4	Danbury.........
23338	Frisbie's Tobacco Manure, 5-8-6...	5-8-6	Burnside.........
23339	Frisbie's Special Tobacco Grower, 5-4-5......................	5-4-5	Ellington.........
22984	Frisbie's Top Dresser, 7-5-4.......	7-5-4	New Haven......
162	Frisbie's Top Dresser, 7-5-4.......	7-5-4	Pequabuck.......
	Godfrey Fertilizer and Chemical Co., Newark, N. J.		
23070	Godfreys' Potato and Truck Grower, 4-8-4................	4-8-4	Westport.........
23071	Godfrey's Potato Manure, 4-8-5...	4-8-5	Westport.........
	International Agricultural Corp., Boston, Mass.		
101	Buffalo Crop Grower...........	5-8-7	Simsbury.........
98	Buffalo General Favorite.........	3-10-4	Hazardville.......
97	Buffalo High Grade Manure......	4-6-10	Manchester.......
100	Buffalo New England Special.....	2-12-4	West Suffield......

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen. In nitrates.	Nitrogen. In ammonia.	Nitrogen. Organic, water-soluble.	Nitrogen. Organic, water-insoluble.	Nitrogen. Total.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So-called "Available."	Potash. As muriate.	Potash. Total.	Station No.
%	%	%	%	%	%	%	%	%	%	%	
0.05	0.93	0.30	0.49	1.77	2.15	0.38	8.69	8.31	2.06	2.06	20
0.24	0.55	0.30	0.58	1.67	2.03	0.68	9.53	8.85	3.07	3.07	22
0.78	0.60	0.32	0.79	2.49	3.03	0.78	9.38	8.60	4.06	4.06	15
1.15	0.78	0.59	0.80	3.32	4.04	0.60	8.64	8.04	3.96	3.96	14
1.08	*0.73*	*0.76*	*0.77*	*3.34*	*4.06*	*0.55*	*7.18*	*6.63*	*10.13*	*10.13*	16
1.27	0.96	0.90	1.00	4.13	5.02	0.75	9.28	8.53	7.50	7.50	21
1.25	0.76	0.68	0.77	3.46	4.21	0.63	8.69	8.06	7.35	7.35	13
1.12	0.58	0.62	1.91	4.23	5.14	0.25	5.25	5.00	0.64	5.19	23
1.55	0.13	0.44	2.06	4.18	5.08	1.23	10.00	8.77	1.46	6.01	24
0.97	0.91	0.49	0.85	3.22	3.91	0.95	11.81	10.86	6.21	6.21	22955
1.39	0.91	0.78	0.86	3.94	4.79	0.53	9.34	8.81	6.54	6.93	22990
....	1.16	0.85	1.78	3.79	4.61	0.50	9.38	8.88	6.66	6.66	23273
0.03	0.83	0.34	0.48	1.68	2.04	0.46	8.40	7.94	2.08	2.08	23042
0.94	0.93	0.59	0.81	3.27	3.98	0.45	9.18	8.73	5.85	5.85	23245
0.89	0.55	0.28	0.67	2.39	2.91	0.65	8.75	8.10	3.89	3.89	23038
0.83	0.62	....	....	2.44	2 97	0.45	8.68	8.23	3.75	3.75	23305
0.83	0.81	1.01	0.50	3.15	3.83	0.44	9.02	8.58	3.65	3.81	22992
....	0.80	0.79	1.44	3.03	3.68	0.40	8.83	8.43	3.64	3.64	23274
1.41	0.56	0.43	1.45	3.85	4.68	0.80	9.40	8.60	1.08	6.17	23338
0.98	0.59	0.46	1.91	3.94	4.79	0.28	5.08	4.80	0.69	5.59	23339
2.65	1.58	0.45	0.69	5.37	6.53	0.27	5.80	5.53	4.05	4.30	22984
....	....	....	....	5.35	6.50	0.28	6.05	5.77	....	3.89	162
0.64	0.83	0.79	0.96	3.22	3.91	1.48	9.56	8.08	4.16	4.16	23070
0.10	1.37	0.42	0.92	2.81	3.42	0.51	8.35	7.84	5.15	5.15	23071
0.00	2.40	0.76	1.09	4.25	5.17	0.55	8.15	7.60	7.05	7.05	101
0.26	1.01	0.37	0.70	2.34	2.84	0.43	10.39	9.96	4.26	4.26	98
0.00	1.77	0.70	0.69	3.16	3.84	0.23	6.41	6.18	10.44	10.44	97
0.28	0.65	0.32	0.54	1.79	2.18	0.72	12.59	11.87	4.20	4.20	100

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **International Agricultural Corp., Boston, Mass.**—*Continued*		
95	Buffalo Tobacco Producer........	5.5-6-5.5	Manchester.......
137	Double Strength Fertilizer, 10-8-10	10-8-10	West Suffield.....
669	Double Strength Fertilizer, 10-8-10	10-8-10	Manchester.......
91	I. A. C. Connecticut Valley Special	7-6-5	Glastonbury......
	Lowell Fertilizer Co., Boston, Mass.		
22875	Lowell Animal Brand, 3-8-4......	3-8-4	Cheshire.........
23244	Lowell Bone Fertilizer, 2-8-2......	2-8-2	Shelton..........
22873	Lowell Potato Phosphate, 4-8-7...	4-8-7	Cheshire.........
23246	Lowell 4-6-10 for Potatoes and Vegetables..................	4-6-10	Moosup..........
23041	Lowell 4-8-4 for Potatoes, Corn and Vegetables..................	4-8-4	Southport........
23037	Lowell 5-8-7 for Potatoes and Vegetables..................	5-8-7	Warehouse Point..
23243	Lowell Tobacco 5-4-5 for Tobacco, Fruits and Vines.............	5-4-5	Warehouse Point..
8	Lowell Tobacco 5-4-5 for Tobacco, Fruits and Vines...............	5-4-5	Windsor..........
23400	Lowell Tobacco Manure, 5-8-6.....	5-8-6	East Hartford.....
22874	Lowell Top Dressing, 7-5-2.......	7-5-2	Cheshire.........
	Mapes Fertilizer and Peruvian Guano Co., New York.		
23410	The Mapes Connecticut Valley Special......................	6-4-7	Suffield..........
23128	The Mapes Corn Manure........	3-8-3	Meriden..........
23415	The Mapes General Tobacco Manure......................	5-4-5	Hartford.........
23330	The Mapes General Truck Manure	5-6-5	Hartford.........
23414	The Mapes General Use Manure..	3-6-4	West Cheshire....
23412	The Mapes Grain Brand.........	2-8-2	Hartford.........
23411	The Mapes Onion Manure........	4-6-4	Hartford.........
23134	The Mapes Potato Manure.......	4-7-5	Hazardville......
22950	The Mapes Tobacco Ash Constituents......................	1-4-15	Suffield..........
23408	The Mapes Tobacco Starter Improved......................	5-6-1	Windsor Locks....
23409	The Mapes Top Dresser..........	10-4-2	Windsor Locks....
23413	The Mapes Tobacco Manure Wrapper Brand....................	7.5-2-10.5	Warehouse Point..

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.						Phosphoric Acid.			Potash.		
In nitrates.	In ammonia.	Organic, *water-soluble.*	Organic, water-insoluble.	Total.	Ammonia equivalent to total nitrogen.	Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	Station No.
%	%	%	%	%	%	%	%	%	%	%	
0.00	2.21	0.41	1.91	4.53	**5.51**	0.18	5.55	**5.37**	0.74	**5.74**	**95**
0.09	4.54	0.31	2.60	7.54	**9.17**	0.41	8.67	**8.26**	1.59	**9.88**	**137**
....	....	....	....	7.88	**9.58**	1.18	8.62	**7.44**	....	**10.39**	**689**
0.77	1.23	0.48	3.22	5.70	**6.93**	2.65	8.80	**6.15**	0.52	**5.77**	**91**
0.87	0.60	0.28	0.85	2.60	**3.16**	0.72	9.22	**8.50**	4.25	**4.40**	**22875**
0.06	0.57	0.36	0.57	1.56	**1.89**	0.73	8.93	**8.20**	2.13	**2.13**	**23244**
1.16	0.80	0.64	0.74	3.34	**4.06**	0.68	9.01	**8.33**	6.99	**7.10**	**22873**
1.05	*0.78*	*0.63*	*0.87*	*3.33*	**4.05**	*0.55*	*7.03*	**6.48**	*10.21*	***10.21***	**23246**
1.05	0.76	0.43	0.89	3.13	**3.81**	0.78	9.03	**8.25**	3.97	**3.97**	**23041**
1.18	0.81	0.93	1.04	3.96	**4.81**	0.85	8.94	**8.09**	6.89	**6.89**	**23037**
0.92	0.51	0.60	1.87	3.90	**4.74**	0.35	5.25	**4.90**	0.58	**5.46**	**23243**
....	....	....	....	4.11	**5.00**	0.20	5.40	**5.20**	....	**5.05**	**8**
1.48	0.13	0.44	2.05	4.10	**4.98**	1.28	9.98	**8.70**	2.30	**6.89**	**23400**
0.00	5.21	0.09	0.17	5.47	**6.65**	0.13	5.85	**5.72**	2.14	**2.14**	**22874**
1.85	0.64	0.89	1.73	5.11	**6.21**	0.95	5.30	**4.35**	0.94	**8.46**	**23410**
0.90	0.29	0.36	1.18	2.73	**3.32**	1.25	10.33	**9.08**	2.34	**3.67**	**23128**
1.10	0.51	0.90	1.76	4.27	**5.19**	2.05	5.30	**3.25**	0.78	**6.08**	**23415**
2.11	0.47	0.42	1.40	4.40	**5.35**	0.70	9.33	**8.63**	2.64	**5.98**	**23330**
0.84	0.40	0.41	1.13	2.78	**3.38**	1.20	9.90	**8.70**	3.22	**4.72**	**23414**
0.37	0.23	0.18	1.07	1.85	**2.25**	1.43	11.33	**9.90**	2.86	**2.86**	**23412**
1.47	0.20	0.29	0.92	2.88	**3.50**	0.65	8.53	**7.88**	0.54	**5.51**	**23411**
1.41	0.21	0.23	1.10	2.95	**3.59**	1.15	9.40	**8.25**	3.69	**5.50**	**23134**
....	....	....	....	1.19	**1.45**	1.68	6.82	**5.14**	1.04	**15.03**	**22950**
1.76	0.44	0.73	1.28	4.21	**5.12**	1.65	9.73	**8.08**	0.62	**2.30**	**23408**
4.59	0.34	1.93	1.00	7.86	**9.56**	0.75	6.60	**5.85**	2.95	**3.92**	**23409**
1.80	0.67	1.08	2.93	6.48	**7.88**	1.43	5.38	**3.95**	1.21	**11.46**	**23413**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station:		
	W. L. Mitchell, New Haven.		
9	5-8-7 Fertilizer	5-8-7	New Haven
175	5-8-7 Fertilizer	5-8-7	New Haven
	New England Fertilizer Co., Boston, Mass.		
23291	New England Corn Phosphate, 2-8-2	2-8-2	Rockville
38	New England Potato Phosphate, 4-8-7	4-8-7	Unionville
23290	New England Superphosphate, 3-8-4	3-8-4	Rockville
23300	New England 5-8-7 for Potatoes and Market Gardens	5-8-7	Meriden
32	New England Tobacco 5-4-5	5-4-5	Warehouse Point
23295	New England 2-8-3 for Vegetables and Grain	2-8-3	Hamburg
39	New England 4-8-4 for Potatoes, Vegetables and Grass	4-8-4	Hamburg
41	New England Tobacco Manure, 5-8-6	5-8-6	Warehouse Point
	Nitrate Agencies Co., New York.		
23154	Naco Brand, 2-8-2	2.8-11.4-2.8	Danbury
23428	Naco Brand, 4-8-4	4-8-4	Westport
23427	Naco Brand, 4-8-7	4-8-7	Westport
23435	Naco Brand, 5-8-7	5-8-7	Canton Center
23429	Naco Brand Equivalent 5-8-7 Genuine Peruvian Guano Mixture	5.7-9.1-8.0	Greens Farms
23419	Naco Brand Peruvian Guano	12-10-2.5	Suffield
23149	Naco Brand No. 12 Peruvian Guano Mixture	5.2-10.5-5.2	Westport
667	Naco Brand No. 12 Peruvian Guano Mixture	5.2-10.5-5.2	Danbury
23155	Naco Brand No. 14 Peruvian Guano Mixture	4.9-9.9-8.6	Danbury
	Olds & Whipple, Inc., Hartford.		
33	Blue Label Tobacco Fertilizer	6-3-6	Warehouse Point
35	Complete Corn, Potato and Onion Fertilizer	4-8-4	South Manchester
23190	Complete Tobacco Fertilizer	5-3-5	Warehouse Point

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.71	2.08	0.52	0.68	3.99	**4.85**	0.53	8.55	**8.02**	6.60	**6.60**	**9**
....	....	....	....	3.85	**4.68**	3.10	11.55	**8.45**	....	**6.22**	**175**
0.07	0.70	0.21	0.66	1.64	**1.99**	0.93	9.75	**8.82**	2.23	**2.23**	**23291**
0.96	0.71	0.83	0.69	3.19	**3.88**	0.63	8.96	**8.33**	6.53	**6.53**	**38**
0.78	0.63	0.31	0.79	2.51	**3.05**	0.65	9.10	**8.45**	4.23	**4.23**	**23290**
0.85	1.10	1.13	0.91	3.99	**4.85**	0.95	9.85	**8.90**	7.23	**7.23**	**23300**
1.27	0.40	0.55	1.85	4.07	**4.95**	0.45	5.55	**5.10**	0.49	**5.13**	**32**
0.03	0.76	0.22	0.60	1.61	**1.96**	0.49	8.37	**7.88**	3.19	**3.19**	**23295**
1.29	0.78	0.53	0.80	3.40	**4.13**	0.58	9.03	**8.45**	4.24	**4.24**	**39**
1.65	0.10	0.46	2.00	4.21	**5.12**	1.05	9.38	**8.33**	1.45	**5.95**	**41**
0.49	0.77	0.54	0.44	2.24	**2.72**	0.93	12.95	**12.02**	2.58	**3.05**	**23154**
0.43	1.49	0.62	0.57	3.11	**3.78**	0.48	9.03	**8.55**	6.17	**6.17**	**23428**
0.50	1.37	0.63	0.70	3.20	**3.89**	0.59	8.28	**7.69**	7.30	**7.30**	**23427**
0.74	1.81	0.51	0.62	3.68	**4.47**	0.85	9.63	**8.78**	5.91	**6.37**	**23435**
0.74	2.05	0.67	0.92	4.38	**5.33**	0.93	10.60	**9.67**	7.08	**7.32**	**23429**
0.00	4.50	1.91	3.77	10.18	**12.38**	1.55	12.05	**10.50**	2.65	**2.65**	**23419**
0.34	1.95	0.56	1.14	3.99	**4.85**	0.77	10.59	**9.82**	5.58	**5.81**	**23149**
....	....	....	....	4.20	**5.11**	0.63	10.90	**10.27**	....	**8.07**	**667**
0.31	1.72	0.80	1.17	4.00	**4.86**	0.90	11.00	**10.10**	8.64	**8.64**	**23155**
1.02	0.10	0.11	3.89	5.12	**6.22**	0.23	4.33	**4.10**	0.69	**7.06**	**33**
0.88	1.06	0.16	1.25	3.35	**4.07**	1.10	9.83	**8.73**	4.32	**4.32**	**35**
1.19	0.00	0.00	3.04	4.23	**5.14**	0.28	4.28	**4.00**	0.70	**5.76**	**23190**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Olds & Whipple, Inc., Hartford.**—*Continued.*		
37	Fish and Potash	3-6-5	Hartford
23195	High Grade Starter and Potash Compound	5-4-15	Hartford
31	High Grade Potato Fertilizer	5-8-7	Wethersfield
34	Special Comp. Corn, Onion and Potash Fertilizer	3-8-2	South Manchester.
	Parmenter & Polsey Fertilizer Co., Boston, Mass.		
23466	4-8-4 for Potatoes, Corn and Vegetables	4-8-4	Wallingford
23481	5-8-7 for Potatoes and Market Gardens	5-8-7	New Britain
23465	"P & P" Plymouth Rock Brand for all Crops, 3-8-4	3-8-4	Plainville
	Frank S. Platt Co., New Haven.		
23462	Platco Special, 4-8-6	4-8-6	New Haven
	The Rogers & Hubbard Co., Portland.		
23434	R. & H. All Soils—All Crops Fertilizer	4-10-4	Somers
23034	Hubbard's Bone Base Fertilizer for Oats and Top Dressing	10-3-8	Branford
23036	Hubbard's Bone Base Fertilizer for Seeding Down	3-5-6	Portland
170	Hubbard's Bone Base Fertilizer for Seeding Down	3-5-6	Westville
23033	Hubbard's Bone Base Soluble Corn and General Crops Manure	3-8-6	Branford
23035	Hubbard's Bone Base Soluble Potato Manure	6-8-5	Branford
7	Hubbard's Bone Base Soluble Potato Manure	6-8-5	Naugatuck
23157	Hubbard's Bone Base Soluble Tobacco Manure	6-8-10	Glastonbury
23436	R. & H. Climax Tobacco Brand	5-4-4	Suffield
23433	R. & H. Corn and Grain Fertilizer	1-10-3	Norwich
23147	R. & H. Garden Fertilizer	2-10-4	Hartford
23425	R. & H. High Potash Fertilizer	3-8-10	Branford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.93	0.01	0.10	1.83	2.87	**3.49**	0.58	7.35	**6.77**	6.40	**6.40**	**37**
1.40	0.13	0.33	2.51	4.37	**5.31**	0.50	4.70	**4.20**	1.67	**16.04**	**23195**
1.39	0.10	0.94	1.78	4.21	**5.12**	2.60	11.10	**8.50**	0.81	**7.15**	**31**
1.23	0.07	0.13	1.12	2.55	**3.10**	2.20	11.20	**9.00**	2.25	**2.25**	**34**
1.36	0.77	0.42	0.89	3.44	**4.18**	0.70	9.25	**8.55**	4.25	**4.25**	**23466**
1.34	1.01	0.55	1.13	4.03	**4.90**	1.13	9.23	**8.10**	6.72	**6.72**	**23481**
0.88	0.66	0.20	0.75	2.49	**3.03**	0.64	8.64	**8.00**	4.22	**4.22**	**23465**
1.02	0.90	0.50	0.91	3.33	**4.05**	0.68	9.48	**8.80**	6.23	**6.23**	**23462**
1.82	0.09	0.87	0.59	3.37	**4.10**	2.58	12.32	**9.74**	4.47	**4.47**	**23434**
7.55	0.05	0.69	0.27	*8.56*	***10.41***	*2.95*	*8.53*	***5.58***	4.94	**7.70**	**23034**
0.97	0.03	0.27	1.40	2.67	**3.25**	5.05	11.38	**6.33**	6.27	**6.27**	**23036**
....	....	....	....	2.53	**3.08**	4.48	11.77	**7.29**	....	**5.84**	**170**
1.17	0.07	0.33	0.96	2.53	**3.08**	2.80	11.05	**8.25**	6.05	**6.05**	**23033**
2.97	0.19	1.05	0.90	5.11	**6.21**	3.47	11.00	**7.53**	0.90	**5.06**	**23035**
....	....	....	....	5.03	**6.12**	3.28	10.80	**7.52**	....	**4.58**	**7**
2.10	0.15	1.94	0.84	5.03	**6.12**	3.24	10.78	**7.54**	1.20	**10.33**	**23157**
1.53	0.03	0.39	2.16	4.11	**5.00**	0.33	5.60	**5.27**	0.54	**4.69**	**23436**
0.10	0.07	0.48	0.54	1.19	**1.45**	2.71	12.46	**9.75**	3.17	**3.17**	**23433**
0.38	0.15	0.80	0.47	1.80	**2.19**	3.42	12.69	**9.27**	3.90	**3.90**	**23147**
1.06	0.07	0.75	0.63	2.51	**3.05**	3.06	10.64	**7.58**	9.65	**9.65**	**23425**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station:		
	The Rogers & Hubbard Co., Portland.—*Continued.*		
23148	R. & H. Potato Fertilizer	2-10-4	Branford
23449	*R. & H. Richmond's Special Tobacco Formula*	5-4-5	New Milford
22964	R. & H. Tobacco Grower, Vegetable Formula	6-4-4	Hartford
22965	R. & H. Tobacco Grower, Vegetable Formula	6-4-4	Hartford
23156	4-8-4 Fertilizer	4-8-4	Guilford
	F. S. Royster Guano Co., Baltimore, Md.		
23443	Royster's Bully Guano	2-8-5	Plainville
23459	Royster's Quality Trucker	4-8-7	Plainville
23453	Royster's Spearhead Guano	3-8-4	Thompsonville
23060	*Royster's Top Dresser*	7-6-5	*Plainville*
23444	Royster's Truckers Delight	4-8-4	Milford
23467	Royster's Valley Tobacco Formula	5-4-5	East Windsor Hill
670	Royster's Valley Tobacco Formula	5-4-5	Granby
23468	Royster's Wrapper Brand	7-3-7	Granby
	Sanderson Fertilizer & Chemical Co., New Haven.		
22993	Atlantic Coast Bone, Fish and Potash	2-8-3	Windsor Locks
23063	Complete Tobacco Grower	5-4-5	Windsor Locks
23451	*Corn Superphosphate*	2-8-2	Hamden
22865	Formula A	4-8-4	Milford
23069	Formula B	4-8-6	Glastonbury
23447	Kelsey's Bone Fish and Potash	3-10-3	Cromwell
23450	Potato Manure	3-8-4	Hamden
22989	Top Dressing for Grass and Grain	6-6-4	New Haven
	M. L. Shoemaker & Co., Philadelphia, Pa.		
23463	Swift-Sure 4-8-5 Potato No. 1	4-8-5	New Milford
23460	Swift-Sure Tobacco and General Use 3-10-3	3-10-3	Thompsonville
23464	*Swift-Sure Tobacco Special*	5-4-5	*New Milford*

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total n	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.34	0.15	0.75	0.50	1.74	**2.11**	2.90	12.81	**9.91**	3.95	**3.95**	**23148**
1.23	0.03	0.28	2.39	3.93	**4.77**	0.20	4.95	**4.75**	0.37	**5.06**	**23449**
1.19	0.10	0.35	3.32	4.96	**6.03**	0.61	5.59	**4.98**	0.51	**4.58**	**22964**
....	....	....	....	4.96	**6.03**	0.55	5.50	**4.95**	0.52	**4.42**	**22965**
1.92	0.03	0.57	0.78	3.30	**4.01**	2.53	10.54	**8.01**	4.07	**4.07**	**23156**
0.00	1.10	0.04	0.58	1.72	**2.09**	0.95	9.20	**8.25**	4.87	**4.87**	**23443**
0.01	2.16	0.18	0.87	3.22	**3.91**	1.23	9.26	**8.03**	6.96	**6.96**	**23459**
0.00	1.73	0.23	0.69	2.65	**3.22**	1.05	9.38	**8.33**	4.69	**4.69**	**23453**
0.78	2.37	0.52	1.37	5.04	**6.13**	0.78	7.45	**6.67**	4.97	**4.97**	**23060**
0.00	2.23	0.41	0.68	3.32	**4.03**	0.58	8.70	**8.12**	3.98	**3.98**	**23444**
0.42	0.78	0.13	2.52	3.85	**4.68**	0.30	4.75	**4.45**	0.36	**4.93**	**23467**
....	....	....	....	3.93	**4.78**	0.48	4.93	**4.45**	....	**5.28**	**670**
0.52	1.29	0.45	2.97	5.23	**6.36**	0.30	3.83	**3.53**	0.77	**7.08**	**23468**
0.02	0.49	0.43	0.71	1.65	**2.01**	0.90	9.05	**8.15**	3.00	**3.11**	**22993**
0.92	0.01	0.13	2.94	4.00	**4.86**	0.18	4.28	**4.10**	0.58	**5.98**	**23063**
0.00	0.42	0.73	0.55	1.70	**2.07**	0.72	8.75	**8.03**	2.22	**2.22**	**23451**
0.76	1.24	0.66	0.52	3.18	**3.87**	1.11	9.15	**8.04**	4.17	**4.17**	**22865**
0.77	0.96	0.24	1.58	3.55	**4.32**	0.83	9.03	**8.20**	0.77	**6.28**	**23069**
0.44	0.71	0.73	0.59	2.47	**3.00**	0.65	10.43	**9.78**	3.22	**3.22**	**23447**
0.44	0.73	0.83	0.46	2.46	**2.99**	0.50	8.80	**8.30**	4.08	**4.08**	**23450**
2.77	1.25	0.54	0.53	5.09	**6.19**	0.40	6.59	**6.19**	4.01	**4.19**	**22989**
0.83	0.07	0.62	1.72	3.24	**3.94**	3.15	12.60	**9.45**	1.58	**5.44**	**23463**
0.89	0.06	0.47	1.21	2.63	**3.20**	2.78	14.28	**11.50**	0.36	**3.08**	**23460**
0.93	0.00	0.47	2.75	4.15	**5.05**	1.75	8.25	**6.50**	0.86	**7.98**	**23464**

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Springfield Rendering Co., Springfield, Mass.**		
23446	Animal Brand 3-8-4	3-8-4	Thompsonville
23445	Market Garden Grower and Top Dresser 5-8-7	5-8-7	Hazardville
23452	Special Potato, Onion and Vegetable 4-8-4	4-8-4	Stafford Springs
23454	Tobacco Special 5-4-5	5-4-5	Thompsonville
	Standard Agricultural Chemical Corp., New York.		
136	Prepared Alphano Humus	1.5	Hartford
127	Super-Alphano	5-7-4	New Haven
	Virginia-Carolina Chemical Co., New York.		
30	Aroostook Potato Grower	5-8-7	Guilford
90	Champion Brand	4-8-4	"
23189	Double Owl Brand	4-8-6	"
93	Fish, Phosphate and Potash Brand	2-8-2	Rockville
94	Indian Chief Brand	5-4-5	Hazardville
23193	Perfection Brand	3-9-5	North Haven
92	Tip-Top Brand	8-6-6	North Haven
666	Tip-Top Brand	8-6-6	New Britain
	Wilcox Fertilizer Co., Mystic.		
132	4-8-4, Fertilizer	4-8-4	Montville
133	5-8-7, Fertilizer	5-8-7	Woodstock
374	5-10-5, Mixture	5-10-5	Ellington
131	Corn Special	3-10-4	Montville
23296	Fish and Potash	3-8-3	Mystic
128	Potato and Vegetable Phosphate	4-8-6	Ellington
23292	Tobacco Special	5-4-5	Ellington
	S. D. Woodruff & Sons, Orange.		
23188	Home Mixed Fertilizer	4-8-6	Orange
	Worcester Rendering Co., Auburn, Mass.		
23475	Prosperity Corn and Grain 2-8-2	2-8-2	Putnam
23476	Prosperity Market Garden 5-8-7	5-8-7	Putnam
23473	Prosperity Potato and Vegetable Fertilizer, 4-8-4	4-8-4	Norwich

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As *muriate.*	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.36	0.54	0.88	0.74	2.52	3.06	0.70	9.25	8.55	4.14	4.14	23446
1.16	0.63	1.18	0.93	3.90	4.74	0.83	9.55	8.72	7.44	7.44	23445
1.41	0.00	0.91	0.74	3.06	3.72	0.65	9.03	8.38	4.18	4.18	23452
1.77	0.00	0.55	1.84	4.16	5.06	0.78	6.23	5.45	0.52	5.43	23454
....	....	....	....	1.55	1.88	....	0.60	....	....	0.29	136
1.11	*1.52*	*0.00*	*1.80*	*4.43*	5.39	*0.38*	*7.52*	7.14	*0.60*	4.17	127
0.04	3.17	0.61	0.23	4.05	4.92	0.95	8.83	7.88	7.13	7.13	30
0.00	2.48	0.46	*0.28*	*3.22*	3.91	*0.93*	9.08	*8.15*	3.75	3.75	90
0.05	2.59	0.41	0.25	3.30	4.01	1.18	8.93	7.75	6.38	6.38	23189
0.13	0.86	0.27	0.40	1.66	2.02	1.13	9.28	8.15	1.76	1.76	93
0.36	0.54	0.39	3.09	4.38	5.33	0.45	4.82	4.37	0.44	4.53	94
0.00	1.91	0.50	0.19	2.60	3.16	1.65	10.23	8.58	5.08	5.59	23193
2.83	2.57	0.57	0.19	6.16	7.49	1.00	6.95	5.95	3.44	4.83	92
....	....	....	....	6.38	7.76	1.09	7.13	6.04	....	5.55	666
1.70	0.17	0.83	0.80	3.50	4.26	0.95	9.53	8.58	4.16	4.16	132
1.79	0.14	0.74	1.30	3.97	4.83	2.48	10.85	8.37	3.93	6.74	133
1.84	0.15	0.85	1.23	4.07	4.95	1.70	11.55	9.85	4.47	5.23	374
0.87	0.12	0.60	0.80	2.39	2.91	0.78	11.25	10.47	4.02	4.02	131
1.07	0.18	0.64	0.77	2.66	3.23	0.83	12.10	11.27	3.36	3.36	23296
1.58	0.09	0.48	1.09	3.24	3.94	1.40	9.85	8.45	2.99	6.19	128
0.00	0.26	1.51	4.14	5.91	7.19	0.28	5.68	5.40	0.73	5.85	23292
1.78	0.00	0.20	1.21	3.19	3.88	1.00	7.97	6.97	10.76	10.76	23188
1.04	0.09	0.20	0.43	1.76	2.14	0.70	9.05	8.35	2.31	2.31	23475
1.17	0.97	0.83	1.11	4.08	4.96	0.79	8.68	7.89	7.12	7.12	23476
0.70	0.77	0.70	1.15	3.32	4.04	0.65	8.75	8.10	4.00	4.00	23473

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Purchaser:		
	American Agricultural Chemical Co., New York.		
75	National Complete Tobacco Fertilizer	5-4-5	Thompsonville
	Armour Fertilizer Works, New York.		
22610	Armour's, 4-8-4	4-8-4	Preston City
22611	Armour's, 5-8-7	5-8-7	Preston City
	The Berkshire Fertilizer Co., Bridgeport.		
22814	Berkshire Tobacco Special	7-3-5	Windsor Locks
22909	Berkshire Tobacco Special	7-3-5	East Windsor Hill
	Bowker Fertilizer Co., New York.		
342	Bowker's Fertilizer, 5-4-5	5-4-5	Suffield
	The E. D. Chittenden Co., Bridgeport.		
23178	Chittenden's Tobacco Special, 5-4-5	5-4-5	Silver Lane
	L. T. Frisbie Co., New Haven.		
23080	Frisbie's, 5-8-7	5-8-7	Manchester
23144	Frisbie's, 5-8-7	5-8-7	Norwich
23143	Frisbie's Special Vegetable and Potato Grower, 4-8-4	4-8-4	Norwich
	International Agricultural Corp., Boston, Mass.		
23387	Tobacco Fertilizer, 7-6-7	7-6-7	Suffield
	New Jersey Fertilizer & Chemical Co., New York.		
22970	"Croxton Big Crop"	5-8-6	New Preston
	Olds & Whipple, Inc., Hartford.		
23076	High Grade Potato Fertilizer, 5-8-7	5-8-7	Windsor Locks

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
....	....	....	....	4.50	5.47	0.38	4.65	4.27	0.44	5.24	75
....	....	....	....	3.48	4.23	....	....	....	....	....	22610
....	....	....	....	2.89	3.51	....	....	....	....	....	22611
....	....	....	....	5.82	7.08	0.26	4.81	4.55	....	5.90	22814
....	....	....	....	6.02	7.32	....	4.11	....	....	6.06	22909
....	....	....	....	3.92	4.77	....	4.68	....	....	4.96	342
....	....	....	....	3.72	4.52	0.38	5.63	5.25	1.33	6.09	23178
....	....	....	....	4.04	4.91	0.75	9.28	8.53	6.94	6.94	23080
....	....	....	....	4.03	4.90	0.73	9.73	9.00	7.22	7.22	23144
....	....	....	....	3.08	3.74	0.68	9.15	8.47	4.26	4.26	23143
).12	2.21	....	....	5.70	6.93	0.35	6.35	6.00	0.47	7.36	23387
....	....	....	....	4.19	5.09	0.83	9.67	8.84	6.22	6.22	22970
....	....	....	....	4.42	5.37	1.57	9.23	7.66	0.97	9.16	23076

TABLE XIV. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade	Place of Sampling.
	Sampled by Purchaser: **The Rogers & Hubbard Co., Portland.**		
22785	R. & H. Tobacco Grower, Vegetable Formula..............	6-4-4	Burnside...........
	F. S. Royster Guano Co., Baltimore, Md.		
140	Royster's Fertilizer, Sample A..	7-3-7	Rockville...........
141	Royster's Fertilizer, Sample B..	7-3-7	Rockville...........
	The Worcester Rendering Co., Auburn, Mass.		
1	6-6-3, Fertilizer...............	6-6-3	Manufacturer's Sample..............

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Concluded.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
....	....	....	....	4.99	**6.07**	0.70	5.19	**4.49**	....	**4.42**	**22785**
....	....	....	....	5.84	**7.10**	....	4.30	....	....	**6.06**	**140**
....	....	....	....	4.48	**5.45**	....	6.70	....	....	**6.57**	**141**
0.48	1.83	0.81	1.37	4.49	**5.46**	0.83	6.70	**5.87**	3.31	**3.31**	**1**

SPECIAL MIXTURES AND HOME MIXTURES.

Twenty-eight samples of home-mixed goods or fertilizers mixed by manufacturers according to formulas furnished by purchasers, have been analyzed and are reported in Table XVII. Eleven were sampled by the Station and the remainder were submitted by purchasers.

TABLE XVII. ANALYSES OF SPECIAL MIXTURES

Station No.	Manufacturer.	Place of Sampling.
	Sampled by Station:	
195	American Agricultural Chemical Co., New York	Arthur Manning, So. Manchester
188	Apothecaries Hall Co., Waterbury	A. F. Newmarker, Rockville
194	Apothecaries Hall Co., Waterbury	Arthur Manning, So. Manchester
193	Berkshire Fertilizer Co., Bridgeport	" "
196	Berkshire Fertilizer Co., Bridgeport	" "
23386	L. T. Frisbie, New Haven	L. P. Hickey, East Hartford
192	Olds & Whipple, Inc., Hartford	Arthur Manning, So. Manchester
22867	....	T. W. Ryan, Stratford
22868	....	T. W. Ryan, Stratford
187	....	Geo. Webster, Rockville
	Sampled by Purchaser:	
22442	....	American Sumatra Tobacco Co., Bloomfield
22443	....	" "
22608	....	" "
22444	....	" "
22590	....	" "
22467	....	" "
22609	....	" "
22489	....	" "
23388	Apothecaries Hall Co., Waterbury	W. J. Burgess, Thompsonville
23348	Berkshire Fertilizer Co., Bridgeport	H. Rashall, Ellington
23176	L. T. Frisbie Co., New Haven	W. T. Clark, Norwich
23074	Olds & Whipple, Inc., Hartford	H. E. Wells, Windsor Locks
23075	" "	H. E. Wells, Windsor Locks
22948	" "	G. Stephen Potwine, Warehouse Point
23029	" "	G. Stephen Potwine, Warehouse Point
23308	" "	H. Whitaker, Hazardville
23309	" "	H. Whitaker, Hazardville
23177	....	Aleck Sullivan, East Windsor Hill

AND HOME MIXTURES.

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In nitrates.	In ammonia.	Organic, water-soluble.	Organic, water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available"	*As muriate.*	Total.	
%	%	%	%	%	%	%	%	%	%	%	
....	....	....	....	5.64	**6.86**	1.18	6.00	**4.82**	0.41	**5.31**	**195**
....	....	....	....	5.35	**6.50**	2.18	8.10	**5.92**	0.78	**8.24**	**188**
....	....	....	....	6.11	**7.43**	0.98	6.15	**5.17**	0.65	**6.24**	**194**
....	....	....	....	7.91	**9.62**	0.80	2.88	**2.08**	....	....	**193**
....	....	....	....	5.69	**6.92**	1.55	6.23	**4.68**	0.64	**5.91**	**196**
....	....	....	....	5.35	**6.50**	0.38	8.53	**8.15**	0.89	**8.70**	**23388**
....	....	....	....	6.12	**7.44**	1.08	6.38	**5.30**	0.36	**6.30**	**192**
....	....	....	....	3.92	**4.77**	1.43	11.37	**9.94**	....	**7.36**	**22867**
....	....	....	....	4.70	**5.71**	0.56	8.20	**7.64**	5.87	**6.12**	**22868**
....	....	....	....	4.76	**5.79**	0.93	9.28	**8.35**	....	**4.64**	**187**
....	....	....	....	5.38	**6.54**	....	5.82	....	0.16	**5.93**	**22442**
....	....	....	....	6.02	**7.32**	....	4.87	....	0.16	**6.04**	**22443**
....	....	....	....	5.64	**6.86**	....	6.83	....	0.31	**7.77**	**22608**
....	....	....	....	6.14	**7.47**	....	5.55	....	trace	**7.54**	**22444**
....	....	....	....	5.53	**6.72**	....	4.64	....	0.29	**8.58**	**22590**
....	....	....	....	5.08	**6.18**	....	4.96	....	0.16	**9.44**	**22467**
....	....	....	....	5.92	**7.20**	....	5.36	....	0.35	**7.74**	**22609**
....	....	....	....	5.21	**6.33**	....	5.39	....	0.15	**8.92**	**22489**
0.08	0.13	....	....	5.59	**6.80**	0.30	6.00	**5.70**	0.57	**9.13**	**23388**
....	....	....	....	6.68	**8.12**	....	3.75	....	0.81	**7.88**	**23348**
....	....	....	....	4.93	**5.99**	0.45	9.88	**9.43**	6.09	**6.09**	**23176**
....	....	....	....	5.92	**7.20**	1.10	6.10	**5.00**	1.44	**11.72**	**23074**
....	....	....	....	5.67	**6.89**	1.06	6.28	**5.22**	1.54	**11.39**	**23075**
....	....	....	....	3.67	**4.46**	....	5.78	....	0.98	**14.03**	**22948**
....	....	....	....	2.95	**3.59**	2.33	14.24	**11.91**	4.99	**4.99**	**23029**
....	....	....	....	5.78	**7.03**	0.28	5.80	**5.52**	0.51	**6.66**	**23308**
....	....	....	....	5.60	**6.81**	0.30	6.00	**5.70**	0.52	**6.73**	**23309**
....	....	....	....	6.16	**7.49**	0.43	3.85	**3.42**	0.76	**5.87**	**23177**

VII. MISCELLANEOUS FERTILIZERS, AMENDMENTS AND WASTE PRODUCTS.

WOOD ASHES.

Twenty samples have been examined. No. **22959** was wet and low in potash. No. **23302** was also low grade. The other samples submitted contained from 4.80 to 7.83 per cent of potash and were of good quality. Wood ashes contain from 1 to 2.5 per cent of phosphoric acid and 30 per cent or more of lime, but they are an expensive source of potash. The prevailing price quoted is $5.00 per unit, which is about five times the cost of other equally available forms of potash.

Analyses are given in Table XVIII.

SHEEP MANURE, ETC.

Fourteen samples of this class of materials have been analyzed, ten of which were sampled by the Station agent. Analyses are given in Table XIX.

Ton prices have ranged from $30.00 to $50.00, the average being about $45 00.

TABLE XVIII. ANALYSES OF WOOD ASHES, ETC.

Station No.	Manufacturer.	Purchaser.	Phosphoric acid.	Water-soluble potash.	Insoluble material.
	Sampled by Station:		%	%	%
2959	John Joynt, Lucknow, Canada	J. E. Lathrop, Burnside.	1.22	2.47	.....
	Sampled by Purchaser:				
3023	John Joynt, Lucknow, Canada	Hatheway & Steane, Hartford	2.03	7.49	12.17
3024	" "	" "	1.90	5.70	24.20
3025	" "	" "	2.33	7.08	14.56
3026	" "	" "	2.28	6.01	14.25
3027	" "	" "	2.40	5.07	16.22
3202	" "	" "	2.25	5.88	11.38
3203	" "	" "	1.80	7.63	6.83
3255	" "	" "	2.10	5.99	13.78
3256	" "	" "	2.95	7.83	11.40
3257	" "	" "	2.08	6.01	10.63
3258	" "	" "	2.08	4.98	18.75
3200	" "	Hunting Bros., East Hartford	2.10	6.86	7.65
3201	" "	Hunting Bros., East Hartford	1.88	6.27	10.43
3283	" "	Henry Sachs, Collinsville	2.18	6.82	8.00
2914	" "	Steane, Hartman & Co., Inc., Hartford	1.93	6.48	8.71
2944	" "	Steane, Hartman & Co., Inc., Hartford	1.47	4.80	7.50
3221	Lucian North, Avon, Conn...	S. W. Eddy, Avon	1.53	7.27	5.08
3028	....	Sperry & Barnes, New Haven	2.08	6.18	4.33
3302	....	A. S. Pons, Bristol	1.45	3.19	12.75

TABLE XIX. ANALYSES OF

Station No.	Manufacturer or Brand.	Purchased, Sampled or Sent By.
23260	American Agricultural Chemical Co., New York City........	Station Agent from Geo. S. Phelps & Co., Thompsonville
23008	Armour Fertilizer Works, New York.....................	Station Agent from Collins & Freeman, Branford.........
23393	Berkshire Fertilizer Co., Bridgeport.....................	Station Agent from C. Buckingham & Co., Southport......
22982	*Sheep's Head.* Natural Guano Co., Aurora, Illinois........	Station Agent from Cadwell & Jones, Hartford............
22991	*Groz-It.* Pacific Manure & Fertilizer Co., San Francisco, Cal.	Station Agent from Meech & Stoddard, Middletown......
23457	*Premier.* Premier Poultry Manure Co., Chicago, Illinois...	Station Agent from Lightbourn & Pond, New Haven........
23458	*Premier.* Premier Poultry Manure Co., Chicago, Illinois...	Station Agent from Lightbourn & Pond, New Haven........
22983	*Wizard.* The Pulverized Manure Co., Chicago, Illinois........	Station Agent from F. S. Bidwell & Co., Windsor Locks.......
23043	*Wizard.* The Pulverized Manure Co., Chicago, Illinois........	Station Agent from F. C. Benjamin, Danbury..............
22986	*So. American Sheep and Goat Manure.* Sanderson Fertilizer & Chemical Co., New Haven	Station Agent from Factory....
180	*Groz-It.* Pacific Manure & Fertilizer Co., San Francisco, Cal.	C. L. Bardo, New Haven......
181	*South American Sheep and Goat Manure.* Sanderson Fertilizer & Chemical Co., New Haven	C. L. Bardo, New Haven......
22811	[1] Pigeon Manure (kept under cover)....................	Karl Jursek, Mt. Carmel......
22812	[2] Pigeon Manure (exposed to weather)..................	Karl Jursek, Mt. Carmel......

[1] Water 42.36%
[2] Water 59.35%

SHEEP MANURE, ETC.

Total nitrogen.	Ammonia equivalent to *total nitrogen*.		Phosphoric Acid.				Potash.		Station No.
			Available.		Total.				
	Found.	Guaranteed.	Found.	Guaranteed.	Pound.	Guaranteed.	Pound.	Guaranteed.	
%	%	%	%	%	%	%	%	%	
2.12	2.58	1.75	....	....	1.30	0.75	2.07	2.00	**23260**
1.31	1.59	1.50	....	....	0.98	1.00	3.04	2.00	**23008**
2.34	2.84	2.18	....	....	1.28	1.00	2.14	2.00	**23393**
2.47	3.00	2.73	1.66	1.00	1.75	1.25	2.07	2.00	**22982**
1.33	1.62	1.80	....	....	0.81	1.25	2.76	3.00	**22991**
1.81	2.20	2.25	0.80	1.00	0.88	1.25	2.57	2.00	**23457**
5.25	6.38	5.00	3.10	1.70	3.28	2.70	1.44	1.30	**23458**
2.07	2.52	2.43	1.36	1.25	1.45	....	2.04	2.00	**22983**
2.01	2.44	2.10	1.05	1.00	1.43	....	1.56	1.00	**23043**
1.30	1.58	1.50	....	....	0.95	1.00	2.70	2.50	**22986**
1.25	1.52	....	....	....	0.90	....	2.94	....	**180**
1.49	1.81	....	....	....	1.00	....	2.87	....	**181**
3.80	4.62	....	....	....	1.76	....	1.39	....	**22811**
0.93	1.13	....	....	....	1.19	....	0.77	....	**22812**

SEWAGE SLUDGE.

142. *Sludge* from Sewage Disposal Plant, Stamford.

Analysis:

Water 17.34 per cent, ash 38.95 per cent, organic and volatile matter 43.71 per cent, nitrogen 2.27 per cent.

21860. *Activated sludge.* Sanitary District of Chicago.

Manufacturer's sample. This is the product obtained in the process of purifying sewage by aeration methods.

Analysis:

Nitrogen in ammonia 0.06 per cent, organic nitrogen 5.42 per cent, total nitrogen 5.48 per cent, active insoluble organic nitrogen 2.93 per cent, inactive insoluble organic nitrogen 1.79 per cent, available phosphoric acid 3.00 per cent, total phosphoric acid 3.91, total potash 0.79 per cent.

The activity of the insoluble organic nitrogen is about 62 per cent by the method employed (alkaline permanganate).

LIME.

The application of lime for purposes of soil improvement has been practiced since very remote times. Marl and ash were used for this by the ancient Greeks and Romans and in early English history the practice of spreading chalk on the land is recorded. The early colonists in America brought the practice with them, and marl, ashes, and gypsum or land plaster are conspicuous in the records of colonial agriculture. With the advent of artificial fertilizers the use of liming materials was largely suspended but modern agricultural practice has restored lime to wider recognition than ever before.

In the earlier sense of the term "lime", a miscellaneous group of calcium-containing materials were included such as marls, chalk, oyster and clam shells, limestone, marble, and the ashes of wood and other organic substances in which calcium is combined wholly or in part as carbonate; gypsum or land plaster which is calcium sulphate; and phosphate of lime which is derived from phosphatic rocks and from bone. The current usage of the term, however, is more restricted and applies chiefly to calcitic and dolomitic limestones, oyster shell lime, calcareous marls and the several forms of lime derived from them.

The practical use of lime in New England may be discussed very briefly as follows:

1. The chief function of lime is to make the soil less "acid". The exact nature of this "acidity" is a matter on which scientists are not entirely agreed, but all agree that lime will change the reaction.

2. The soils of Connecticut are usually acid, due to lime deficiency of the rock from which they are derived, the relatively high leachiness of our soils, and the long period of time which

most of the tillable area has been under cultivation. Also, due to the variable factors of original soil material, leachiness and past agricultural practice, our soils vary widely in the degree of acidity.

3. We are not so much concerned with soil acidity as such, as with the success of a large number of crops such as clover, alfalfa, timothy, redtop, tobacco, potatoes, tomatoes, lettuce, beets, carrots, spinach and many others. It has also been shown, particularly by the Rhode Island Station, that crops vary greatly in their sensitiveness to acidity and in their response to applications of lime. For instance, red top, strawberries and watermelons do very well under acid conditions while others, like beets, onions and alfalfa, require a condition much less acid. Certain diseases, like potato scab and tobacco root-rot, are controlled by keeping the soil moderately acid.

4. A knowledge of the intensity of soil acidity is manifestly of great importance as a guide to farm practice in regard to any given crop to be grown. The "litmus paper" test was formerly used in this connection, but it is not sufficiently sensitive to show the finer distinctions in soil reaction that modern research has shown to be necessary, and there are much better methods, which, while far more perfect, do give a fairly accurate estimate of the degree and intensity of the acidity.

5. Our liming practice should therefore be based on the following information:

a– What crops are to be grown?
b– What amounts of stable manure are used?
c– What kinds and amounts of fertilizer are used?
d– When, in what form and what amounts has lime been used?
e– What is the reaction of the soil?

This last can be learned by sending representative samples from various fields to the Experiment Station. Such samples should be accompanied by the information indicated in a, b, c and d above, if advice is desired relative to the use of lime.

The inference should not be drawn that we now have accurate information on all the problems concerned with "acidity," but progress is being made and on certain crops there is quite accurate information.

The relation between actual lime (calcium oxide, CaO), and the several natural and manufactured lime products is illustrated as follows: If 100 lbs. of pure crushed limestone are burned in a kiln at suitable temperature (650-900 °C. or 1200-1650 °F.), 56 pounds of actual lime (calcium oxide, CaO), are obtained, the remaining 44 pounds being lost in the form of carbon dioxide gas (CO_2). This actual lime is known also by other names such as "stone lime" or "quicklime". Actual lime or quicklime is very

irritating to handle and in practice slaked lime is more often used. This is obtained by treating quicklime with water, with which it combines vigorously with the production of considerable heat. There is enough moisture in the air to accomplish the slaking process, but a longer time is required. The 56 lbs. of actual lime obtained from the original 100 lbs. of limestone will obviously increase in weight as it combines with water and will weigh 74 lbs. when completely slaked. This slaked lime is otherwise known as hydrated lime, calcium hydrate or calcium hydroxide. When quicklime is allowed to air-slake, however, it absorbs carbonic acid as well as moisture from the air so that the product is a mixture containing some quicklime, hydrated lime and carbonate of lime, or, in other terms, calcium oxide, calcium hydrate and calcium carbonate.

The changes described take place also in the case of limestones which contain magnesium (dolomitic limestones), the product of burning being in such cases the mixed oxides of lime and magnesia.

Commercial liming materials are judged on the basis of actual lime and magnesia (oxides of calcium and magnesium), which they contain, and upon their degree of fineness. The various products are quite variable in composition but in general they will contain mixed oxides about as follows:

Material	Oxides of calcium and magnesium ($CaO + MgO$)
Carbonates:	%
Limestone	45–55
Oyster shell	40–50
Marl	40–50
Burned Lime:	
Hydrated lime, high grade, less than 10% carbonates	65–75
Low grade, mixture of hydrate and carbonate	55–65
Lime ashes	50–60

The effectiveness of lime in the soil will depend directly upon its degree of fineness. Neither the carbonates nor hydrated limes are readily soluble in soil water and the rate at which they will be dissolved will depend upon the size of the particles. The smaller the grains the greater the relative amount of surface exposed to the action of the solvent.

Fineness of Lime.

Since there is a direct relationship between the fineness of lime products and their rate of availability in the soil, it might appear that the greatest degree of fineness is desirable. Yet because of the cost of grinding the lime to a very fine condition and the rapidity with which such material disappears in the soil, a medium ground lime seems to be the more desirable commercial product. A reliable authority assumes that pulverized limestone, all of which will pass a 10 mesh sieve, 70% of which will pass a 50 mesh

sieve, and 50% of which will pass a 100 mesh sieve, should give excellent results and yet be cheap enough to make its use worth while. In Ohio the standard required by law for agricultural ground limestone is that 95% of the material shall pass a 10 mesh screen, 50% shall pass a 50 mesh screen, and 30% shall pass a 100 mesh screen.

If immediate effects are desired in the use of moderate quantities of lime for a special crop of high money value, extreme fineness may be desirable, regardless of the greatly increased cost. This is usually obtained in hydrated limes.

In table XX are given analyses of 46 samples of lime. Some of these were collected and examined two years ago but the results have not been published.

Comments on Analyses.

22349. This was a sample of limestone dust which accumulated in the manufacture of poultry grit and was not offered for sale as an agricultural lime.

23030, 23031, 23254. The first two samples were submitted by purchasers. The manufacturer advised that the analysis of **23030** was quite unlike the composition of their product as shown by frequent check analyses of their own. Accordingly an official sample, **23254,** was drawn which was supposed to be the same material as **23030** but was sampled from different stock. This showed a composition substantially in accord with the manufacturer's claim and in agreement also with purchaser's sample **23031.** Evidently **23030** had become mixed with some material containing a relatively large amount of insoluble matter.

The cost of lime, so far as ton prices have been quoted to us, show considerable variation. Thus, four quotations for limestone have varied from $6.75 to $10.00 per ton. For hydrated lime, containing from 62 to 77 per cent of effective oxides, prices have ranged from $9.50 to $15.00.

TABLE XX. ANALYSES OF

Station No.	Manufacturer or Brand.	Place of Sampling.
	Ground Limestone.	
	Manufacturer Unknown.	
23482	Berkshire Ground Limestone	Southport
	C. W. Coe & Sons, Northford.	
23494	Ground Limestone	Factory
	Kapailo Mfg. Co., Inc., New York.	
22349	Limestone Dust	New Haven
	Grangers Mfg. Co., West Stockbridge, Mass.	
19944*	Grangers Agricultural Limestone	Hazardville
19945*	" "	Suffield
19946*	" "	Waterbury
23030†	" "	Hartford
23031†	" "	Avon
23254	Grangers Limestone	Windsor
334	Grangers Limestone	Rockville
	Clifford L. Miller, West Stockbridge, Mass.	
23491	Monarch Brand	Bridgeport
	The Stearns Lime Co., Danbury.	
18529*	Ground Limestone	Danbury
18561*	" "	Roxbury
19941*	" "	Branford
	White Marble Products Co., Ashley Falls.	
18530*	Ground Limestone	Ashley Falls, Mass.
18560*	Ground Limestone	Roxbury
	Hydrated Lime.	
	Cheshire Lime Mfg. Co., Cheshire, Mass.	
20013*	Agricultural Lime	Hartford
	Conn. Lime Co., Canaan.	
19943*	Agricultural Lime	Hartford
19948*	Dry Hydrated Lime	Litchfield
19949*	Air Slacked Lime (waste)	Canaan
20014*	Canaan Agricultural Lime	Canaan
20017*	Lee Hydrate, Conn. Brand	East Canaan
20018*	Air Slacked Lime (waste)	Canaan
23485	Agricultural Lime	Hartford
23486	Burned Lime Screenings	Ellington
	Hoosac Valley Lime Co., Adams, Mass.	
23077†	Agricultural Lime	Warehouse Point

* Analyzed in 1922.
† Sampled by Purchaser.

LIMESTONE, ETC.

Chemical Analysis.							Mechanical Analysis.					
Lime (CaO).		Magnesia (MgO).		Total oxides.	Insoluble in acid.	Carbon dioxide.	20 mesh.	40 mesh.	50 mesh.	80 mesh.	100 mesh.	Station No.
Found.	Guaranteed.	Found.	Guaranteed.									
%	%	%	%	%	%	%	%	%	%	%	%	
41.95	.....	9.17	.....	51.12	6.13	28.18	95.00	85.50	76.50	67.00	63.50	**23482**
52.91	.....	0.70	.....	53.61	3.21	.....	78.50	61.00	52.50	45.00	43.00	**23494**
30.74	.....	21.09	....	51.83	1.85	.....	.....	100.00	87.00	59.00	50.00	**22349**
36.80	35.00	9.84	1.00	46.64	13.84	.....	.....	.....	82.00	....	53.50	**19944**
35.72	35.00	9.78	1.00	45.50	16.22	.....	.....	.....	77.50	....	59.50	**19945**
43.46	35.00	6.88	1.00	50.34	8.80	.....	.....	.....	67.00	....	42.00	**19946**
39.96	.....	0.65	.....	40.61	28.83	.....	100.00	100.00	99.50	94.50	89.50	**23030**
51.82	.....	0.97	.....	52.79	6.85	.....	100.00	100.00	99.00	92.00	87.00	**23031**
50.68	.....	1.26	.....	51.94	8.70	.....	100.00	100.00	99.50	93.00	89.00	**23254**
51.85	.....	0.58	.....	52.43	6.37	41.22	.....	.....	.....	.....	.....	**334**
43.27	36.87	8.42	13.72	51.69	5.63	39.46	98.00	87.00	77.00	66.00	62.50	**23491**
41.80	.....	4.87	.....	46.67	.....	.....	.....	.....	88.80	.....	76.30	**18529**
43.17	.....	.....	.....	.....	13.27	.....	.....	.....	.....	.....	.....	**18561**
46.06	43.00	4.44	2.00	50.50	9.45	.....	.....	.....	85.50	.....	65.00	**19941**
29.98	.....	20.62	.....	50.60	.....	.....	.....	.....	77.40	.....	48.80	**18530**
30.74	.....	.....	.....	.....	1.60	.....	.....	.....	.....	.....	.....	**18560**
61.28	58.00	2.48	0.60	63.76	1.36	.....	.....	.....	.....	.....	.....	**20013**
47.38	.....	31.37	27.00	78.75	1.78	4.41	.....	.....	.....	.....	.....	**19943**
48.36	.....	30.46	.....	78.82	1.89	6.11	.....	.....	.....	.....	.....	**19948**
30.51	.....	20.67	.....	51.18	1.48	10.21	.....	.....	.....	.....	.....	**19949**
44.14	52.00	29.25	23.00	73.39	1.00	3.90	.....	.....	.....	.....	.....	**20014**
46.98	.....	32.08	.....	79.06	1.48	1.98	.....	.....	.....	.....	.....	**20017**
39.80	.....	27.80	.....	67.60	1.23	.....	.....	.....	.....	.....	.....	**20018**
51.62	.....	12.51	.....	64.13	1.33	15.47	91.00	72.00	58.50	47.50	44.50	**23485**
41.44	.....	27.23	.....	68.67	1.00	4.32	73.00	43.50	34.00	28.50	27.50	**23486**
60.58	58.00	0.69	0.50	61.27	3.38	.....	75.50	52.50	39.50	29.00	26.00	**23077**

TABLE XX. ANALYSES OF

Station No.	Manufacturer or Brand.	Place of Sampling.
	Hydrated Lime.	
	Knickerbocker Lime Co., Philadelphia.	
23489	Knickerbocker Hydrated Lime	Glastonbury
	Lee Lime Co., Lee, Mass.	
22830†	Hydrated Lime	Hartford
22831	Agricultural Lime	Hartford
23492	Lee Hydrated Agricultural Lime	Pequabuck
	Clifford L. Miller, Stockbridge, Mass.	
22833†	Hydrated Agricultural Lime	Avon
	New England Lime Co., Danbury.	
20012*	Adam's Granular Finishing Lime	Windsor Locks
20016*	Connecticut Agricultural Lime	East Canaan
20015*	" "	New Milford
19942*	" "	Willimantic
22832†	Hydrated Lime	Avon
22861†	Agricultural Hydrated Lime, Nelco Brand	Hartford
23483	Burned Lime	Southport
23488	Connecticut Agricultural Lime	New Hartford
23490	Hydrated Mason Lime	Milford
23493	Granular Lime	Hartford
340	Connecticut Agricultural Lime	Middlefield
	Rockland & Rockport Lime Corp., Rockland, Me.	
20187*	R. R. Land Lime	Somers
22856†	R. R. Land Lime	Hartford
23487	R. R. Land Lime, High Calcium Lime	Hazardville
308	R. R. Land Lime	Granby

* Analyzed in 1922.
† Sampled by purchaser.

LIMESTONE, ETC.—*Concluded*

Chemical Analysis.							Mechanical Analysis.					
...e (CaO).		Magnesia (MgO).										
	Guaranteed.	Found.	Guaranteed.	Total oxides.	Insoluble in acid.	Carbon dioxide.	20 mesh.	40 mesh.	50 mesh.	80 mesh.	100 mesh.	Station No.
	%	%	%	%	%	%	%	%	%	%	%	
.0	45.00	29.42	30.00	75.52	1.39	1.56	100.00	100.00	99.00	97.00	95.00	**23489**
57	45.00	33.30	39.00	81.87	1.10	0.71	100.00	100.00	99.00	96.00	94.00	**22830**
.6	.....	28.18	.....	70.34	0.80	11.89	55.00	33.00	27.00	24.00	23.00	**22831**
25	.....	32.53	.....	80.78 [1]	1.21	1.36	100.00	100.00	98.00	95.00	94.00	**23492**
.6	.....	7.60	.....	71.06	1.43	6.09	99.00	94.00	85.00	75.00	70.00	**22833**
58	.....	4.45	.....	91.83	1.82	2.74	.....	.....	.....	.....	.....	**20012**
56	40.00	31.44	15.00	77.30	0.84	3.00	.....	.....	.....	.....	.....	**20016**
20	40.00	32.53	15.00	80.73	2.73	4.12	.....	.....	.....	.....	.....	**20015**
.8	.....	21.00	.....	71.48	3.39	4.85	.....	.....	.....	.....	.....	**19942**
.5	.....	24.14	.....	71.79	1.61	13.64	100.00	100.00	99.00	96.00	93.00	**22832**
.5	49.34	29.39	33.54	72.04	1.31	12.59	100.00	100.00	100.00	98.00	96.00	**22861**
.4	.....	30.75	.....	76.89	0.88	1.58	81.50	67.00	59.50	55.00	54.50	**23483**
.1	.....	30.57	.....	77.88	1.65	1.55	100.00	100.00	100.00	98.00	96.50	**23488**
.9	.....	30.04	.....	76.73	1.86	0.88	100.00	100.00	100.00	98.00	96.50	**23490**
.3	.....	1.34	.....	88.67	2.07	5.84	68.50	36.50	20.50	9.50	7.50	**23493**
23	72.00 [2]	31.38	7.00 [3]	77.61	1.95	1.51	100.00	100.00	100.00	98.50	97.00	**340**
.2	60.00	1.69	0.80	63.31	2.00	.....	.....	.....	.....	.....	.....	**20187**
.0	60.00	1.24	0.50 [4]	61.74	3.22	20.35	95.00	86.00	78.00	68.00	65.00	**22856**
.5	60.00	2.35	0.50 [4]	62.30	3.85	15.88	96.00	88.00	79.50	66.50	63.00	**23487**
0	60.00	1.20	0.50 [4]	67.60	....	10.67	98.50	94.00	90.00	83.00	79.50	**308**

[1] Guaranty: Total oxides 85 per cent.
[2] Guaranty: 70-80 per cent.
[3] Guaranty: 7-10 per cent.
[4] Guaranty: 0.5-5.0 per cent.

MISCELLANEOUS.

23430. *Potash-Marl.* Potash-Marl, Inc., New York. Sampled by the Station agent from stock of F. H. Leggett & Co., Stamford. Only phosphoric acid is guaranteed.
Analysis:

Available phosphoric acid found 0.42 per cent, guaranteed 0.47 per cent, total 1.05 per cent, guaranteed 1.30 per cent.

This material may contain 6 per cent or more of potash not, however, in water soluble forms. The phosphoric acid and total potash in this fertilizer are probably overvalued at $5.00 per ton but the price quoted is $40.00.

174. *Carbit.* The Hyper-Humus Co., Newton, N. J. This material was sampled from the stock of Olds and Whipple, Inc., Hartford. The chief value claimed for it by the manufacturers is to be found in the beneficial bacteria with which it is inoculated. The Station cannot judge its worth from that standpoint. It is recommended for tobacco and its usefulness can only be determined by experiment.

23235 and **23370.** *Hair Tankage.* Berkshire Fertilizer Co., Bridgeport. Sampled by Station agent at the factory. The two samples contained 2.74 and 3.34 per cent of ammonia respectively. It was guaranteed to contain 3 per cent ammonia.

22966. *Base Goods.* The Rogers and Hubbard Co., Portland. This material was examined for quality of its nitrogen as follows:

Nitrogen in nitrates 0.26 per cent, in ammonia 0.68 per cent, water-soluble organic 2.02 per cent, water-insoluble organic 2.18 per cent, total 5.14 per cent.

The activity of the insoluble organic nitrogen was 66.2 per cent by the alkaline method and 89.6 per cent by the neutral method.

22498. *Burnt Bone.* This was a waste product sent by R. E. Gerth of West Hartford. Most of the nitrogen had been destroyed but the phosphoric acid content was 38.92 per cent.

22967 and **22699.** *Coal.* The first was a sample of Station coal and the second was submitted by C. Q. Eldredge of Mystic. They contained 8.56 and 21.77 per cent of ash respectively.

Eight other samples of unclassified materials including soils require no particular comment.

CHECK COTTONSEED MEAL AND CHECK FERTILIZERS.

The laboratory has continued its co-operation in the program of the American Oil Chemists' Society in testing weekly samples of cottonseed meal, and of the Royster Guano Co. in analyzing monthly samples of various fertilizers. Thirty samples of meal and twelve of fertilizers have been reported.

BULLETIN 262 DECEMBER, 1924

Connecticut Agricultural Experiment Station
New Haven, Connecticut

The Rainbow Forest Plantations

Guide to Experimental Plots
and
Report of Progress
1924

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December, 1924.

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The Wilson H. Lee Co.

The Rainbow Forest Plantations

Guide to Experimental Plots

and

Report of Progress

1924

By

HENRY W. HICOCK

INTRODUCTION

HISTORY AND DESCRIPTION OF TRACT.

The Rainbow Forest Plantations of the Connecticut Agricultural Experiment Station occupy approximately 100 acres in the towns of Windsor and East Granby, about one-half mile west of the village of Rainbow. The land was purchased at a low figure because its value for field crops had been demonstrated to be very low. As a matter of fact, cultivation had been given up several years prior to its acquisition by the Station and it was in various stages of reversion to forest growth. During recent years adjoining property, on which the soil differs but very little from that on the greater part of the Station land, has been cleared and utilized for the production of shade grown tobacco. The land now occupied by the plantations would probably yield a greater return per acre if utilized for shade tobacco instead of for the production of forest crops.

The tract lies on a practically level bench about 100 feet in elevation above the Farmington River and 160 to 180 feet above sea level. The soil* on the major portion of the area is what was originally mapped by the U. S. Bureau of Soils in 1899 as "Windsor Sand", which name was changed in their Bulletin 96 to "Merrimac Coarse Sand." It is part of a deep deposit of glacial outwash material which forms an extensive plain in this portion of the state. The soil is a coarse sand, containing less than 10% of silt and clay, and the texture is very nearly the same to the depth of many feet. The surface soil contains sufficient organic matter to give it a medium brown color to a depth of 5 to 7 inches. The subsoil is of a yellowish color to a depth of about 3 feet, where it grades gradually to the dull gray which is imparted to it by the

*Notes on soil conditions furnished by Mr. M. F. Morgan of the Dept. of Soils, Connecticut Agricultural Experiment Station.

undiscolored coarse granules of impure quartz sand which predominate.

In small local areas (referred to in the plot descriptions as "barren areas") near the western border of the tract, expecially in Plots 16, 44 and 45, the soil is somewhat coarser than is the rule, and contains so little silt and clay that it has even less coherence than usual. On such areas all plant growth is either much stunted or is altogether lacking. The change from these areas to those that support a normal plant growth is very abrupt. Trees planted on the sterile spots either grow very slowly or do not survive at all. Red pine seems to make a little better growth on them than does white, but the needles of both are yellow and in general the trees are crooked and sickly.

On the higher ground in the northeastern portion of the tract, especially in Plots 68 and 69 and in the northern portions of Plots 59 and 60, the soil is finer in texture consisting of about 7 inches of medium brown loamy sand surface soil, with a yellow subsoil of a similar texture to a depth of about 2½ feet overlying the unweathered glacial till. The latter is made up largely of a mass of red shale and sandstone rock fragments of moderate size (less than 6 inches in diameter), with a considerable admixture of grayish sand and fine gravel. This soil type was identified in the 1899 Bureau of Soils Survey as "Enfield Sandy Loam" but this name was changed to "Manchester Fine Sand" in U. S. Bureau of Soils Bulletin 96.

The natural forest growth of the region is inferior hardwoods (mostly grey birch and oaks) and pitch pine, with some chestnut and white pine. The latter species is the only one to make good growth although the chestnut did well before it was attacked by the blight. Land abandoned for agriculture first seeds in to broom sedge and similar plants, followed by grey birch and pitch pine. Later stages of reversion show a diminution of grey birch and an increase of inferior oaks and pitch pine, with some white pine coming in.

The plantations were begun in 1901 on the present tract and in 1902 on another known as Mundy Hollow. The latter was abandoned after a few years. The plans were made for the first Forester of the Station, Mr. Walter Mulford, by the U. S. Forest Service, and comprised an elaborate series of experiments in artificial regeneration of hardwoods and conifers by seeding and planting. The tract was divided up into plots varying in size from ¼ acre to 6 acres in area, a large percentage of them averaging about 1 acre. Wherever feasible, the plots were laid off as rectangles. Numerous methods were tried out. These are described later under individual plots, insofar as the results of these methods are now present. Many of the earlier experiments were complete failures and in such cases no specific reference is made to them in this publication but the reader is referred to Reports of the Station for the years 1906, 1907 and 1912.

Some method of artificial regeneration has been undertaken nearly every year since the plantations were started, the amount varying with the funds available, until at present practically the entire tract is under some kind of forest cover.

For a number of years a nursery was operated in connection with the tract but this practice was abandoned and stock procured either from the Station nursery at Mt. Carmel or by purchase from commercial nurseries.

The plantations have always been used as a field laboratory for the study of insects and fungi by the Entomological and Botanical Departments of the Station, and since 1919 as an object of field study by students from the Yale School of Forestry, who have laid off sample plots and made thinnings in some of the older stands. This work is recorded under individual plots.

The tract has been under the general oversight of a local resident since its inception. Mr. Judson Leonard had charge from 1901 to 1909; Mr. Henry Palmer, from 1909 to 1920. Mr. Frederick M. Snow, the present superintendent, lives near the end of the Rainbow trolley line and about ½ mile from the plantations. He will be glad to aid visitors in every way possible. Forestry operations have so far consisted of planting, cleaning, a small amount of thinning and control of the white pine weevil. Such work has been done either by the local superintendent, by members of the staff of the Forestry Department or by students from the Yale School of Forestry.

As yet the tract has not produced sufficient revenue to pay expenses, although carrying charges have been considerably lessened by the sale of cordwood from cleanings, of some chestnut and large pitch pine for saw-logs, of overtopped spruce for Christmas trees and of Mugho pine for ornamental purposes. In time the tract as a whole should become nearly self-supporting although it will probably never be wholly so.

Only a small amount of planting is needed to bring the entire tract under a forest cover. Future operations will consist of thinning the older stands as they need it, of weevil control, of cleanings and other improvement cuttings, of pruning experiments, of experiments in the most effective methods of cutting hardwoods to obviate rapid sprouting, etc.

The amount of damage from various causes has been relatively small. A rather elaborate system of exterior and interior fire lines, which are harrowed frequently, has been instrumental in keeping the burned area under 6 acres during the last 22 years. Rodents kept the red oak cut back so that experiments with this species are almost a complete failure. Several species of insects have proved troublesome but in only one case has an insect destroyed the entire value of an experiment. The locust borer, *Cyllene robiniae*, mined the trunks and limbs of the black locust so severely that the experiments with this species have been

abandoned. The insect requiring the most work to control is the white pine weevil, *Pissodes strobi*, which attacks the terminal shoot of white pine, Japanese red pine, Mugho pine and Norway spruce, thus deforming the stem. White pine is most severely attacked, followed by the others in the order named. Cutting and burning the infested leaders is the most practical method of control. This work is needed annually. Norway spruce seems to recover better from the injury than do the pines. The spruce gall, *Chermes abietes*, has made much of the Norway spruce unsightly and has probably impaired the growth to some extent although no stunting is apparent and no trees have been killed. The chestnut blight, *Endothia parasitica,* persistently kills back the chestnut trees used in the early experiments. Two rusts have also been found on different species of pines. One, *Peridermium cerebrum*, found on jack pine, has for its alternate host, various species of oaks. This rust was evidently brought in from Michigan on the planting stock and no new outbreaks have been found. The other rust, *Peridermium pyriforme*, which has for alternate hosts two species of toadflax, *Comandra pallida* and *C. umbellata*, has been found on Austrian, Scotch and bull pine. On the first two species it does not seem to have done much damage beyond deforming a few trees. The bull pine, however, seems more susceptible. A few trees die from the disease each year and indications are that the species will eventually be killed out here.

Description of Plots.

Following is a description of the seventy plots which make up the tract. A preliminary survey was made by Mr. S. E. Parker in March, 1923 and all measurements and counts are as of that date unless otherwise noted. Heights were taken with a 10 foot pole or with a Faustmann hypsometer, and diameters with a diameter tape.

Plot 1. Exotic conifers. Area about .7 acre. Planted in the spring of 1907 by sections as follows: east side, Austrian pine, 2 year seedlings, spaced 5 x 5 feet; center, European larch, 2 year seedlings, 5 x 6 feet; west side, Scotch pine, 2 year seedlings, 6 x 6 feet. In 1911 a fire destroyed about ⅔ of the plot and in 1913 the blanks were filled with Douglas fir, 7 year transplants and Chinese arbor-vitae, 6 year transplants. Two partial rows of Japanese red pine planted about 1913 occur on the west side of the plot. A description of this species under Plot 5 will cover this part of Plot 1. The arbor-vitae was a complete failure and the fir, coming from Pacific Coast seed, was not hardy and is represented by a few stunted trees. The failure of these two species has left the stand quite open and irregular although some native pitch pine helps to increase the density. Scotch pine has made the best growth, averaging 23 feet tall and 3 inches in diameter. The

trees are fairly uniform in size but are somewhat crooked. Austrian pine has done fairly well, averaging 9 feet tall and 1.4 inches in diameter. The larch averages 1 foot taller than the Austrian pine but individuals vary greatly, some equaling the Scotch pine in height while others are mere shrubs. The plot was cleaned by lopping hardwood brush in 1919. Several individuals of Scotch and Austrian pine infected with *Peridermium pyriforme* (See page 106) were removed in 1910.

Plot 2. White pine. Area .8 acre. Planted in the spring of 1907 with 2 year seedlings, spaced 6 x 6, 5 x 5, 4 x 4, and 3 x 3 feet In 1911 a fire destroyed the north end of the plot including the 4 x 4 and 3 x 3 foot spacings and in the spring of 1913 blanks were filled with 8 year white pine transplants spaced 5 x 5 feet, thereby destroying the value of the original experiment in different spacings. On the unburned south end only about ten per cent of the trees are missing and the stand is just closing. Only a few trees have any dead limbs. The average size on the 6 x 6 foot spacing is height 13 feet, diameter 2.0 inches and on the 5 x 5 foot, height 9 feet; diameter 1.9 inches. The 1913 planting averages 5.5 feet high but is very open and irregular owing to the failure of about 50% of the trees. Weevil damage (See page 106) amounts to 25% for the plot as a whole. A more recent fire (1923) destroyed about ⅓ of the 1913 planting. The plot was cleaned by lopping birch in 1919.

Plot 3. Pitch pine. Area 1.3 acres. In 1902 seed sown on cultivated strips 1½ feet wide and 4 feet apart as follows: on the south half at the rate of 2 pounds per acre and on the north half at the rate of 1 pound per acre. The seed was brushed in. On the south half a very dense stand resulted. Trees average 1 foot apart in the rows, 17 feet in height and 2 inches in diameter, and have dead limbs for 8 feet above ground. About 60% of the trees have died from crowding. The stand on the north half is not so dense. Trees average 6 feet apart in the rows, 15 feet in height and 3 inches in diameter, and have dead limbs for 3 feet above ground. Very few trees have died from crowding. Spacing in the rows is not uniform and the stand on both sections is very uneven, especially on the north half but here gaps are being filled by natural seeding. Several trees badly infected with *Peridermium pyriforme* were removed in 1910. On both sections the trees have the poor form characteristic of pitch pine in this region. Compare with Plot 49.

Plot 4. White pine—Red oak—Scotch pine. Area .7 acre. Planted in the spring of 1904 with red oak, 3 acorns in a hole, and white pine 2 year seedlings, spacing 6 x 6 feet, a solid row of oak alternating with a row of oak and pine mixed. Losses were small for the first three years. Since then rodents have kept the oak cut back so that at present only 40 % of them are living and of

these only 15% have made even fair growth. However, an occasional individual has done nearly as well as the pine showing that the species will grow on poor soil if not attacked by rodents. About 1913, gaps caused by failure in the oak on the south end of the plot were filled with Scotch pine; the north end remains unfilled, leaving the white pine spaced 12 x 12 feet. With this wide spacing the white pine is thick boled, badly deformed by weevil and shows dead branches for only 3-4 feet. Where Scotch pine has been used it has closed the stand and is approximating the white pine in height. It has dead branches for 3-4 feet above ground but it has not yet influenced the pruning of the white pine growing with it. Average sizes: heights,—white pine, 19 feet; red oak, 7 feet and Scotch pine, 16 feet: diameters,—white pine, 4.5 inches; red oak, 1.0 inch and Scotch pine, 3.0 inches. The north end of this plot may be compared with Plots 48 and 51 where red oak and white pine were planted together but with different arrangement of species and the south end with Plots 35, 36 and 37 where Scotch pine has been used as a filler in older white pine plantations..

Plot 5. Japanese red pine and White pine. Area 1.4 acres. Planted in the spring of 1910 with Japanese red pine 2 year seedlings, spaced 6 x 6 feet. The following summer was very dry and a 50% loss resulted. Blanks were filled in the spring of 1911 with 3 year transplants of the same species. Further failures resulted and in 1913 blanks were filled with white pine 4 year transplants. The present stand is practically complete and is made up of ⅔ Japanese red and ⅓ white pine. The plot is just about to close. It has been kept free of hardwood competition and is therefore open grown. The Japanese red pine shows a 10% damage by weevil as compared with 45% for the white pine. The latter averages 8 feet in height and the former 7 feet. The Japanese red pine does not appear to be a good tree to plant in the open because of its tendency to divide at the base into many stems. In the spring of 1924 all leaders, except one, were removed from each Japanese red pine in an attempt to make this species produce one good stem. The results of this work are not yet apparent but the plot may be compared with Plot 52 where this tree has been grown under similar conditions without reducing the number of leaders. The plot may also be compared with Plot 19 where the species was grown for about 10 years under a dense shade of birch. Japanese red pine has borne cones very prolifically for a number of years and many seedlings up to 10 inches tall are growing in the openings.

Plot 6. Western yellow (bull) pine and White pine. Area 2.7 acres. Planted in the spring of 1908 with bull pine 2 year seedlings, spaced 5 x 5 feet. Losses up to 1912 had amounted to 45% and in 1912 and 1913 blanks were filled with 4 year white pine transplants. Further losses have occurred and these have

not been filled, so that the present stand is 35% bull pine, 35% white pine and 30% blanks. The white pine, even though it has been very heavily damaged by weevil (65%), now equals the bull pine in height which now averages 6.5 feet. The bull pine is subject to attack by ***Peridermium pyriforme***, a fungous disease which kills a few trees each year. In fact, it seems probable that this disease may eventually kill out the species here. Compare with Plot 66.

Plot 7. White pine. Area 2.3 acres. Planted in the fall of 1913 with 3 year transplants, spaced 6 x 6 feet, as a test of fall planting. The experiment was a complete success, over 95% of the trees being alive at present. The stand is irregular, the trees varying in height from 2 to 10 feet and averaging 6 feet. This unevenness is due to some extent to weevils which have attacked 60% of the trees but numerous individuals are stunted without having been attacked by weevil. The stand apparently underwent a period of stagnation for about eight years and the irregularity may be due to the fact that some trees are recovering sooner than others. This stagnation period is characteristic of all white pine plantations on the tract. The species seems to grow slowly for a longer period after planting than most of the others used. The plot has had numerous weevil cuttings and was entirely cleared of birch in the winter of 1921-1922.

Plot 8a. Red pine and Norway spruce. Area 1.7 acres. Cleared in the winter of 1921-1922 of birch for cordwood and planted in the spring of 1922 with red pine and Norway spruce 3 year transplants, spaced 6 x 6 feet, and alternating by rows except the four rows on the west side which are all pine. Most of the birch was at the south end of the plot. The plantation is over 90% complete but the pine averages 18 inches tall and looks thrifty, whereas the spruce is only 6 inches in height and is yellow and sickly except where it received shade from small birch sprouts. It would seem that this mixture is not feasible in the open as the pine will probably suppress the spruce in the same way that the white pine did on Plot 69, leaving the red pine spaced 6 x 12 feet with the spruce forming an understory. The mixture might have been more successful under a heavy brush cover which would have held back the pine more than the spruce and acted as a nurse for the latter until it was well started. (See plot 42.)

Plot 8b. Norway spruce. Area 1.3 acres. Cleared with Plot 8a leaving a few scattering native white pines about 15 feet high. Planted in the spring of 1924 with 2 year seedlings, spaced 5 x 5 feet, as a Christmas tree experiment. The stock was small, the season dry, and only about 10% of the trees survived the first summer. Plot may be compared with Plot 18 where white spruce stock of the same size was planted under an overwood. The latter

plantation is over 90% complete thus demonstrating the value of cover during the early years.

Plot 8b contains much chestnut from an experiment started in 1903. It is interesting to note that this species, even though killed back repeatedly by blight, still persists on this poor leachy soil better than most of the hardwoods used, red oak and locust excepted.

Plot 9. Pitch pine and Hardwoods. Area about .6 acre. Natural growth, not planted.

Plot 10. Norway spruce. Area about .6 acre. Planted in 1912 under a stand of old growth chestnut. Spacing is irregular but averages about 8 x 8 feet. The chestnut died and was removed in 1922 leaving a younger growth, consisting principally of oak, as a cover for the spruce. This cover was opened up in the spring of 1923 to give the spruce more light and will be further reduced or removed at a later date. The spruce has grown slowly but the trees are healthy, except for a small amount of weevil damage, and show every indication of coming through and forming a stand. Spruce is very tolerant and while it will not make fast growth under dense shade it will persist for a long time and, when released, makes a good recovery and increases in size rapidly. Compare with Plot 42, an older spruce plantation under shade which has been reduced from time to time.

Plot 11. Native white pine. Birch cutting experiment. Area .7 acre. The north end of the plot has been devoted for some years to an experiment in bringing a scattered stand of natural reproduction of white pine through a heavy cover of old field grey birch. The pine is doing fairly well but has been badly weeviled and is of poor form.

In October, 1924, an experiment was started to determine the sprouting qualities of birch under different methods of cutting at different times of year. This experiment should give some valuable information on the best season to release plantations and the best cutting methods to use in order to get a minimum of sprouts. The experiment was laid out as a number of different series of four sections each, each series to be cut at a different time of year. One series was cut during October, 1924. Another will be cut in the spring of 1925, and still another in mid-summer, 1925. The four sections in each series are as follows:

a. Check—no cutting.
b. Birch cut off close to the ground.
c. Birch lopped off 2 to 3 feet above ground.
d. Birch lopped partly off and bent over so that the trees will still continue to live.

Plot 12. White pine. Area .6 acre. Planted in the spring of 1902 with 3 year seedlings, spaced 5 x 5 feet, under a cover of grey

birch 15 to 20 feet tall. Fail places were filled in the spring of 1904 with 3 year transplants. The cover was removed in 1910 and 1911 and a final release cutting was made in 1919. This is one of the best plantations of white pine on the tract. Because of the heavy cover for the first 10 years the average growth has not been rapid (average height 19 feet and diameter 3 inches) but the trees are of excellent form, uniform in size and with almost no injury from weevil. Dead limbs extend to 7 feet above the ground and are quite small. Annual height growth almost doubled after the cover was removed in 1910-11.

Plot 13. Norway spruce and Balsam fir. Area about 1.2 acres. In 1910, 71 balsam firs were planted along the northern border of Plots 11 and 12, and about 1916 the remainder of the plot with the exception of a narrow strip to the west of Plot 12 was planted with Norway spruce. Spacing is irregular but averages about 8 x 8 feet. Planting was done under a moderately heavy cover consisting of old pitch pine and a lower stand of hardwoods. Both spruce and fir average 5 feet tall and show the effect of too much shade. However, they are of good color and look healthy, and on removal of the overwood, should make an increased growth in height. The cover was thinned in the fall of 1923 to give the planted trees more light but a further thinning is needed as the cover is still too dense.

Plot 14. Scotch pine. Area 1.2 acres. Planted in the spring of 1907 with 2 year seedlings, spaced 5 x 6 feet, the trees set in furrows plowed through the brush to try out Scotch pine in competition with an advanced hardwood growth. A part of the brush was removed in 1910 and the balance in 1913. A second release cutting was made in 1919 and third in 1924. This should be the last one needed. In addition, several large chestnuts were removed from the south side in 1921. The experiment was only a partial success because, in spite of frequent releasings, the hardwoods killed out over ⅓ of the pine. However, those that have survived have made good growth and are in sufficient numbers to form the final stand. Average height 22 feet; diameter 4.5 inches. Dead branches extend for 10 feet above the ground. This plot demonstrates very well the inadvisability of attempting to grow Scotch pine under any kind of cover. The species is very intolerant and cannot stand even moderate shade. Compare with Plot 23 which was kept entirely free of brush.

Plot 15. White pine. Area .9 acre. Planted in the spring of 1906 with 3 year seedlings, spaced 5 x 6 feet. This plot was started and has been treated in about the same manner as Plot 14, but the trees show far less injury from hardwood competition than do the Scotch pines. About 90% of the trees are still living and the result is a very dense stand with trees averaging 19 feet in height and 3.5 inches in diameter. Dead branches extend for

6 feet above ground. All brush was cleaned from the plot in 1913 and a second and final release cutting was made in 1919. Weevil damage has been very slight, probably because of the density of the stand and the fact that the trees were in brush for seven years. The stand offers a good example of the results of close spacing, i. e., good form with small side branches that are killed early. It is probably too dense for practical purposes as the first thinning will not yield enough to pay for making it. All vegetation has been shaded out and 2 to 3 inches of needles cover the ground.

Plot 16. White pine—Red pine—Japanese red pine. Area 3.7 acres. Spacing 5 x 5 feet. Planted in 1917 as follows: west side, pure red pine; center, white pine and Japanese red pine alternating by rows; and east side, red pine and white pine alternating by rows. The red pine has made the best growth, averaging 5 feet in height, followed by the white with 4 feet and the Japanese red with 3 feet. The stand is practically complete, blanks amounting to less than 15%. The white and the Japanese red pines have both been attacked by the weevil, the former more heavily than the latter. The Japanese red has developed the same bushy habit as in Plots 5 and 52, and is bearing cones prolifically but no seedlings were found. The stand has not yet closed although the pure red pine on the west side has nearly done so. Except immediately under the trees, the crowns have not killed out the vegetative cover. Numerous barren areas occur on this plot. (See page 104.)

Plot 17. Headquarters Site. Area .9 acre. The east end of this plot is used as a location for a portable headquarters cabin. The remainder of the plot which was formerly the old nursery site contains an assortment of many kinds of trees left in the old nursery rows, together with enough later plantings of red and white pine to make up a stand.

In October, 1924, an experiment in pruning young conifers was started directly behind the cabin in a planting of red pine made in the fall of 1919. The experiment includes some 50 trees divided about equally among 4 rows. The row nearest the cabin was pruned to leave a leader and two whorls of branches, the next to leave a leader and one whorl, the third to leave a leader and 3 whorls and the fourth left unpruned as a check. For row 1 (east), the live crown averages about ½ the total height of the tree; for row 2, ⅓ the height; for row 3, ⅝ the height; and for row 4, the entire height. A whorl of branches is to be removed from each row (the check excepted) each year, the object being to find out how much the crowns can be reduced without diminishing the growing power of the trees.

Plot 18. White spruce. Area .7 acre. Planted in the spring of 1924 with 2 year seedlings, spaced 8 x 8 feet, under a cover made up of pitch pine 8 to 10 inches in diameter with an understory of

smaller hardwoods. Less than 10% of the trees had died at the end of the first growing season, demonstrating the fact that spruce (2 year stock) can be planted successfully on a leachy soil if given sufficient protection against drying out. This plot may be compared with 8b where small stock of Norway spruce was planted in the open, the result being almost a complete failure. The cover should be removed, or at least greatly reduced, within five years.

Plot 19. Japanese red pine. Area 1.2 acres. Planted in the spring of 1910 with 2 year seedlings, spaced 6 x 6 feet. Loss was heavy and blanks were filled in 1911 with 3 year transplants of the same species. There were further failures and at present the stand is only 50% stocked. In 1919 the hardwoods, which had completely outgrown the pine, were thinned but not heavily enough and in 1922 they were removed altogether. The interesting feature on this plot is that hardwood competition forced the pine to confine its growth normally to one stem. As a matter of fact this competition was so severe that it caused the pine to become very slender and crooked. Since releasing, however, the trees have recovered and made a much increased height growth. Weevil damage has amounted to very little and the production of cones has been small. This plot forms a very marked contrast to Plot 5 where this species was planted in the open. The average height on Plot 19 is 12 feet, nearly twice that on Plot 5. It would seem that the proper conditions under which to grow this tree successfully would be under a cover kept sufficiently dense to prevent the pine from producing several stems, but not dense enough to cause suppression and crooked, slender boles. The species seems to be fairly tolerant of shade, probably ranking with red pine in this respect.

Plots 20 and 21. White pine and Scotch pine. Area 1.3 acres each. Planted in the spring of 1910, using 4 year transplants of white pine and 2 year seedlings of Scotch pine. Spacing 5 x 5 feet, the species alternating by rows. Scattered white pine set out in 1904 were ignored in the 1910 planting. The experiment does not promise to be a success. The Scotch pine is growing faster than the white and probably will suppress it. In fact the Scotch pine compares favorably with the white planted in 1904. Failures have amounted to over 30%, chiefly in the white pine and the stand is ragged and has not closed. The Scotch pine has dead limbs for a height of 4 feet, while the white has no dead limbs. The Scotch pine averages 17 feet in height and 3 inches in diameter; the white averages 10 feet tall and 2½ inches in diameter (1904 planting excluded). Weevil damage in the white pine has been very slight, due probably to the fact that this species has always been shorter than the Scotch and therefore protected by it. These plots demonstrate that it is not feasible to plant white and Scotch

pine at the same time in mixture. Comparison may be made with Plots 4, 35, 36, 37 and 56 where Scotch pine was used as a filler in white pine plantations that were much older, and with Plot 34 where white pine was used as a filler in a Scotch pine stand that was several years older.

Plot 22. Red pine and White pine. Area .8 acre. Planted in the spring of 1902 with red pine 4 year transplants, spaced 4½ x 5 feet (except for about 100 trees at the north end which are white pine apparently planted at the same time and with the same spacing). Failures in the red pine were filled in 1904 with the same species. The stand has but few blanks. The red pine averages 20 feet tall and 3.8 inches in diameter and the white, 16 feet tall and 2.4 inches in diameter. Red pine has dead branches for 7 feet above ground while the white has them for only 4 feet. The dead branches on the red pine are small, brittle and may be broken off easily though most of them still persist. The white pine has been damaged but very little by weevil, probably because this block of trees is almost completely surrounded by taller trees. This plot may be compared with Plots 23, 28 and 49, all of which were planted at the same time and under about the same conditions, but with different species. The spacing on Plot 22, as well as on Plots 23, 24 and 28, is too close from a practical standpoint. The first thinning will not yield enough returns to pay for making it. Theoretically, the narrow spacing is ideal insofar as it causes the trees to produce small side limbs which die early.

Plot 23. Scotch pine. Area .6 acre. Planted in the spring of 1902 with 3 year seedlings, spaced 4 x 5 feet. The plot has been kept free from hardwood competition and there have been practically no failures. Scotch pine has shown the best growth of any tree used on the tract, with the possible exception of black locust. Heights now average 29 feet and diameters 3.5 inches, while some individuals have reached a height of 33 feet and a diameter of 5 inches. Dead branches extend for 14 feet above the ground and are quite rotten, more so than those of red and white pine of the same age and spacing. The trees are of good form although there is the usual tendency of this species to make crooked boles. Scotch pine is quite intolerant, more so than either red or white pine. So far as can be judged from 20 years of growth, Scotch pine is an excellent tree for use on sandy soils provided it does not have to compete with hardwoods. Compare with Plot 14 for the effects of hardwood competition and with Plots 22, 24, 28 and 49 for the results from planting other species at the same time and under approximately the same conditions.

A few trees infected with *Peridermium pyriforme* have been removed from this plot but the disease does not seem to have made much headway and little trouble is expected from it with this species.

In 1919 students from the Yale School of Forestry laid off and thinned a sample plot covering .089 acre. After thinning there were left on this plot 122 trees which is at the rate of 1,370 per acre. The volume of these trees was 96.3 cu. ft.* of wood or 1,083 cu. ft. per acre.

In 1924 this sample plot was thinned again removing 50 trees or 562 per acre and 39.9 cu. ft. of wood or 448 cu. ft. per acre. After this second thinning there were left 72 trees or 808 per acre and 89.2 cu. ft. of wood or 1,002 cu. ft. per acre. The increase on this plot for the 5 years 1919-1924 had therefore been at the rate of 368 cu. ft. per acre, or 74 cu. ft. per acre per year.

In 1920 another sample plot covering .0804 acre was laid off as a check for the one described above and left unthinned. The number of trees on this plot was 167 or 2,077 per acre and the volume 111.9 cu. ft. or 1,392 cu. ft. per acre. This plot was remeasured again in 1924 at which time there were 151 trees (16 having died from natural causes) or 1,878 per acre. The volume of these was 135.05 cu. ft. of wood or 1,679 cu. ft. per acre. The increase for the four years 1920–1924 had therefore been 287 cu. ft. per acre or 72 cu. ft. per acre per year. Both sample plots will be remeasured and the thinned plot will be thinned again in 1929.

Plot 24. Austrian pine—Red pine—White pine. Area .4 acre. Planted as follows: south end, Austrian pine 4 year seedlings, spaced 4 x 5 feet, summer of 1902; center, red pine 4 year seedlings, spaced 4½ x 5 feet, spring of 1902; north end, white pine, spaced 4½ x 5 feet, 1905.

The plot is chiefly red pine, the Austrian and the white consisting of two blocks of about 100 trees and 50 trees respectively. The white pine being younger is not compared with the others. The Austrian averages 23 feet tall and 4 inches in diameter and the red 21 feet tall and 3 inches in diameter, but the former tends to have a crooked bole. The Austrian pine has dead branches for 10 feet above ground while the red pine has them for only seven. A carpet of needles 2 to 3 inches deep covers the ground and all vegetation has been shaded out. Red pine on this plot, as well as on Plot 22, has not grown as fast as Scotch pine on Plot 23, but is straight boled and generally of better form than the latter. The fact that the Austrian pine averages greater in height and diameter than the red pine may be due to the fact that the total number of the former is relatively small and a greater percentage of the trees border on roads which gives them more growing space. Austrian pine on Plot 24 has been subject to a small amount of infection by *Peridermium pyriforme* but little damage has resulted.

In 1920 students from the Yale School of Forestry laid off a sample plot covering .0919 acre in the red pine. The results of

*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

the counts and measurements were: number of trees 162 or 1,763 per acre; volume 82.4 cu. ft.* of wood or 897 cu. ft. per acre. This sample plot will be remeasured and thinned and a check plot established in 1925.

Plot 25. White pine, wild stock. Area .8 acre. Planted in the spring of 1902 with collected seedlings 8 to 18 inches tall from Granby. Fail places were filled in 1903 with hardwoods, which died and were replaced with wild stock in 1905. Spacing 4½ x 5½ feet. Practically all the pines planted are present but a considerable number are dead from crowding. Heights average 23 feet and diameters 4 inches. Dead branches extend for 7 feet above ground and are small but quite persistent. Weevil damage has been relatively small, due possibly to close spacing. As an experiment in the use of wild stock this plot is a success but at present it would probably cost more to collect such stock than to buy it from a nursery. Compare with red, Scotch and Austrian pine on Plots 22, 23 and 24, and with other white pine from nursery stock on Plots 12 and 28.

Note. The form of the crowns on Plot 25 is quite different from those on Plot 28 which was planted at the same time but with nursery stock. On the latter plot the side branches are quite long, project nearly in a horizontal plane, are interlocking and are dead for 9 feet above ground. The crowns of the wild stock have short slender branches which tend to grow upward. They do not seem to have interfered with each other greatly and are dead for only 7 feet above ground. The general appearance of Plot 25 closely resembles that on 12 where nursery stock was planted and remained for nearly 10 years under a dense cover.

Plot 26. White pine with various spacings. Area 1.2 acres. Planted in the spring of 1903 with 2 year transplants spaced 6 x 6 feet on the south end, 5 x 5 feet in the center, and 4 x 4 feet on the north end. Failures amounting to about 10% occurred in each section. At the end of 10 years the trees with the 4 x 4 foot spacing had made the best growth but at 20 years the 6 x 6 foot spacing had produced larger trees than either of the others, the average being 20 feet in height and 4.3 inches in diameter. The 5 x 5 foot spacing is next with a height of 16 feet and a diameter of 3.5 inches, and the 4 x 4 foot spacing last with a height of 14 feet and a diameter of 2.2 inches. The trees with the 4 x 4 foot spacing showed the greatest height growth between the 8th and 12th years, falling off after that time. Those with the 6 x 6 foot spacing have grown rapidly since the fifth year. Those in the 5 x 5 foot section have grown slowly during the entire period. Damage by weevil has been heaviest in the 6 x 6 foot spacing and lightest in the 4 x 4 foot.

*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

Vegetation has been killed out in all three sections and 2 to 3 inches of needles cover the ground. With all three spacings, trees have dead limbs for 7 feet above ground, but this amounts to about 50% of the total height in the 4 x 4 foot section and only 30% in the 6 x 6 foot. All dead limbs are quite firm. Those on the 6 x 6 foot spacing are much larger than on the others. Because it results in less injury from weevil and in the production of small side branches, the 4 x 4 foot spacing would be more satisfactory if thinnings could be made at about the fifteenth year. As this is not feasible, it is probably better to grow this species with a wider spacing, attempting to get protection from weevil and to prevent the growth of side limbs by using a hardwood cover, and thinning it gradually for the first 15 years.

Plot 27. White pine. Area 1.0 acre. Planted in the spring of 1904 with white pine 2 year seedlings and chestnut 1 year seedlings, 2 rows of pine and 2 rows of chestnut, spacing 5 x 5 feet. The chestnut failed and the chestnut rows were filled in the spring of 1910 with white pine 4 year transplants spaced 6 feet apart in the rows. The results of using white pine as a filler in an older plantation of the same species are not entirely satisfactory. The older pines are bushy with no dead limbs and have been heavily damaged by weevil. They average 17 feet in height and 4.4 inches in diameter while the 1910 trees average 11 feet in height and 1.8 inches in diameter. The latter show only a 10% damage by weevil and are generally of good form. The plot as a whole is quite ragged and uneven and has not closed. The 1910 planting may, because of better protection from weevil and side crowding from the 1904 trees, develop into a stand of good form but the final results will probably not be as good as if the stand were even-aged throughout. This plot may be compared with Plots 4, 35, 36, 37 and 56 where Scotch pine was used as a late filler.

Plot 28. White pine. Area 1.6 acres. Planted in the spring of 1902 with 3 year seedlings and 4 year transplants. Failures were replaced 1904-5 with transplants. A part of this plot was cultivated and fertilized for several seasons but no results of this treatment are apparent. Spacing 4 x 5 feet although many trees are only 3 feet apart and often two or more were planted together. The resultant stand is very dense and many trees are dying from lack of space. Average height, 19 feet; diameter, 3.5 inches. Dead branches extend for 9 feet above the ground and are small but persistent. Weevil damage has been slight. The stand shows the effect of too keen competition and should be thinned immediately in order not to further reduce the amount of living crown. This plot does not compare favorably with Plots 22, 23 or 24 where red and Scotch pine were planted at the same time and with about the same spacing. The stand should have been thinned at 15 years. All vegetation has been shaded out and several inches of needles cover the ground. (See note under Plot 25.)

In 1920 students from the Yale School of Forestry laid off a sample plot covering ⅛ of an acre. The results of the counts and measurements were: number of trees 245 or 1,960 per acre, volume 95.6 cu. ft.* of wood or 764.8 cu. ft. per acre. This sample plot will be remeasured and thinned and a check plot established in 1925.

Plot 29. White pine. Area 2.3 acres. Planted in the fall of 1907 with 3 year transplants, spaced 5 x 5 feet, to test the results of fall planting. The experiment is a moderate success, less than 25% having failed. The stand as a whole, however, is quite ragged and uneven due to the blanks and to the fact that some individuals have grown very slowly. Weevil damage has been quite heavy. Crowns have not closed enough to kill the lower branches and shade out herbaceous growth. The plot was cleared of birch in 1919. Heights average 15 feet and diameters 3.5 inches. For other examples of fall planting see Plots 7 and 69a.

Plot 30. Jack pine. Area .3 acre. Planted in the spring of 1908 with seedlings from Michigan 1 to 2 feet high, spaced 5 x 5 feet. A 50% failure resulted and the present stand is rather open and uneven. It has not yet closed sufficiently to kill the lower branches or to shade out herbaceous cover. Although a few individuals have done well, generally the trees have crooked boles and long side branches. Average height, 16 feet; diameter, 3 inches. In 1910 several trees infected with *Peridermium cerebrum* (See page 106) were removed. This disease was evidently introduced with the stock as no further infections have been found. This pine is bearing cones prolifically and many seedlings up to 12 inches tall may be found in the openings. The plot should be compared with Plot 47 where Jack pine was used as a late filler.

Plot 31. Scotch pine. Area .3 acre. Planted in the spring of 1903 with green ash 1 year seedlings, spaced 10 x 10 feet. In the spring of 1904 Scotch pine 2 year seedlings were planted 5 feet apart in solid rows between the ash rows and alternating with the ash in the rows, making the final spacing 5 x 5 feet. The ash failed thereby reducing the density 25% and this, plus a 5% failure in the pine, leaves the plot about 70% stocked. The stand is very dense and has completely closed. Average height 25 feet; diameter 4.8 inches. Dead limbs extend for 12 feet above ground and the lower ones, though still persisting are quite rotten. They seem to be a little larger than on Plot 23. From the appearance of this plot it would seem that Scotch pine may be planted with a much wider spacing, 7 x 7 or 8 x 8 feet, and still close and prune satisfactorily. The effect of this would be to delay the first thinning until the stand was 30-35 years old when the operation

*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

a. Plot 38. Douglas fir and white pine planted in 1903. Note the great variation in size of the fir.

b. Plot 69. Norway spruce and white pine planted in 1905 in the open. The pine has overtopped 90% of the spruce.

PLATE II

a. Plot 5. Japanese red pine planted in 1910. Note the bushy habit of this species when grown in the open.

b. Plot 42. Norway spruce and white pine planted in 1906 under an overwood which has since been removed. The spruce is holding its own with the pine. Compare with Plate I b.

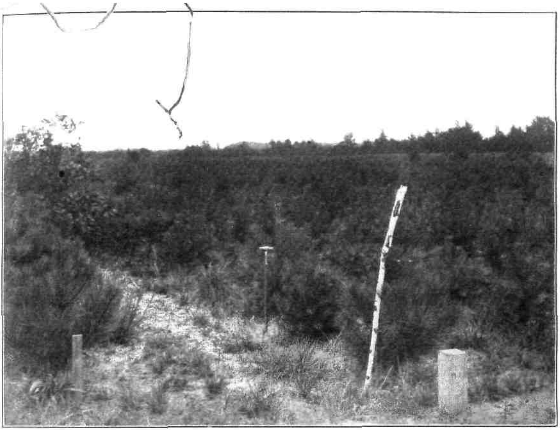
a. Plot 30. Jack pine planted in 1908.

b. Plot 68. White pine planted in 1905.

PLATE IV

a. Fire line between Plots 60 and 68 in 1912. Compare with Plate VII b.

b. Looking north across Plot 23 in 1903, one year after Scotch pine was planted. Note character of ground cover.



a. Red and Scotch pine on Plots 22 and 23 in 1905.

b. Red and Scotch pine on Plots 22 and 23 in 1912.

PLATE VI

a.

b.

Plot 23. Scotch pine planted in 1902.

PLATE VII

a. Plot 24. Red pine planted in 1902. Compare with Plate VI.

b. Fire line between Plots 60 and 68. See Plate IV a.

PLATE VIII

a. Plot 6. Bull pine planted in 1908, white pine in 1913. Bull pine with the axe leaning against it was killed by the rust.

b. Plot 16. Red pine planted in 1917.

would probably more than pay for itself. The trees are bearing cones prolifically and seedlings up to seven years old may be found around the edges of the plot. All vegetation has been shaded out and a carpet of needles several inches deep covers the ground. Compare with Plot 23.

Plot 32. Norway spruce. Area 1.5 acres. Planted in the spring of 1905 with 2 year seedlings, spaced 5 x 5 feet, under an open growth of pitch pine and hardwoods. The ground had been burned over just before planting. A second fire burned over a portion of the area in 1907 and in 1910 blanks were filled with 4 year transplants. In 1911 a 50% failure had resulted and in 1913 all blanks were filled with 7 year transplants after removing a part of the overwood. In 1923 a fire burned over about 1/8 of the plot near the East Granby highway. This has not been replanted. Exclusive of the recent burn the plot is now only about 50% stocked. The trees seem well established but average only 4 feet in height and show the effect of too dense cover. With the removal of the overwood the stand should recover and increase in height rapidly although it will always be quite open. A few trees of another species, probably white spruce, occur near the southern edge of the plot, also an occasional balsam fir. Many trees, both of Norway and the other spruce, are heavily infested with galls. (See page 106.)

Plot 33. White pine. Area 2.1 acres. Planted in 1905 with 2 year seedlings, spaced 5 x 5 feet, under a medium dense sbade of pitch pine and hardwoods. The overwood was thinned in 1913 and birch was lopped back on the west side in 1923. The white pine has not made a rapid growth but the plot is 80% stocked (excluding a 1923 burn covering about a half acre) and the trees are of good form and have not been damaged to any extent by weevil. The white pines are growing into the crowns of the pitch pines and the latter should be removed. Heights average 11 feet; diameters 1.7 inches.

Plot 34. Scotch pine—White pine—Mountain pine. Area .9 acre. Planted in the spring of 1911 with 4 year Scotch pine transplants and 3 year mountain pine seedlings, spaced 6 x 6 feet. About 90% of the latter failed and the blanks were filled in the spring of 1913 with 5 year white pine transplants. About 20% of the Scotch and 10% of the white pine are missing. After the failure of the mountain pine the experiment resolved itself into determining the value of white pine as a filler in an older Scotch pine stand. The results are not promising. The Scotch pine has made a very rapid growth and has spread out so that it nearly closes over the white pine. In fact, it is quite probable that in a few years it will completely suppress the white and form a pure Scotch pine stand spaced 6 x 12 feet. This may prove a desirable density for Scotch pine as it will delay the need of thinning.

The Scotch pine now averages 11 feet in height and 3.1 inches in diameter, while the white is only 6 feet tall. The white pine has been weeviled but very little. As a whole the stand has not closed sufficiently to shade out herbaceous growth or to form a litter of needles. Compare with Plots 4, 35, 36, 37 and 56 where Scotch pine was used as a filler in an older white pine stand.

Note. The mountain pine proved to be of the Mugho variety. Mugho pine when crowded, will abandon its prostrate habit and send up a single stem. In several cases it has reached a height of 6 feet or more. It is attacked to a slight extent by the white pine weevil.

Plot 35. White pine and Scotch pine. Area 2.0 acres. The experiments started in 1903 as an example of mixed planting by groups. Two year transplants of white pine and various hardwoods were planted with a spacing of 4½ x 5 feet and mixed by grouping 3 to 10 trees of each species together. Blanks in the pine were filled with 3 year transplants in 1904. The hardwoods practically all failed and in the spring of 1911 were replaced with Scotch pine 3 year transplants. The present stand is about ¼ white and ¾ Scotch pine minus a few blanks caused by failures. The white pine because of its greater age has made a bushy growth with long side branches. It averages 15 feet in height and 3.4 inches in diameter. Weevil damage has been quite heavy. The Scotch pine has grown rapidly and has nearly caught up with the white. It averages 13 feet in height and 3.2 inches in diameter. The stand is just closing and few trees show any dead branches. Herbaceous growth has been shaded out and 1 to 2 inches of needles cover the ground. The Scotch pine should overtake the white in a few years and it remains to be seen whether it will eventually suppress the white or not. The plot was thoroughly cleaned by lopping birch and girdling pitch pine in 1924. Compare with *Plots 4, 34, 36, 37 and 56.*

Plot 36. White pine and Scotch pine. Area .9 acre. Planted in the spring of 1903 with white pine 2 year transplants and maple seedlings alternating in the row and spaced 6 x 6 feet. Pine blanks were filled in 1904 with 3 year transplants. The maple failed and was replaced in 1908 with 2 year Scotch pine seedlings. The Scotch pine now averages 18 feet in height and 3.8 inches in diameter and the white, 16 feet in height and 3 inches in diameter. The stand has just closed. All herbaceous growth has been shaded out and 1 to 2 inches of needles cover the ground. Scotch pine has dead branches for a height of 5 feet and white pine for 3 feet. The Scotch was probably used too soon as a filler. It looks now as though it would soon close over and suppress the white, although the latter may respond to crowding with an increased height growth. Compare with Plots 4, 34, 35, 37 and 56.

In 1923 students from the Yale School of Forestry laid off a sample plot covering ¼ acre. The results of the counts and measurements were: number of trees—white pine 162, Scotch pine 125 or 648 and 500 trees per acre, respectively. Volume—white pine 57.4 cu. ft. of wood*, Scotch pine 66.8 cu. ft. or 229.6 cu. ft. and 267.2 cu. ft. per acre, respectively. This sample plot will be remeasured and thinned and a check plot established in 1928.

Plot 37. White pine and Scotch pine. Area 1.0 acre. Planted in the spring of 1903 with white pine 2 year transplants and maple seedlings, spaced 6 x 6 feet, solid rows of maple alternating with a row of maple and pine mixed. The maple was a failure and was replaced in 1911 with 3 year transplants of Scotch pine. Not over 10% of blanks now exist. The Scotch pine has surpassed the white in diameter and in height. It now averages 16 feet tall and 2.8 inches in diameter, while the white is 12 feet tall and 2.2 inches in diameter. The Scotch pine has dead limbs for 3 feet above the ground but the white has live limbs clear to the ground. The stand has closed, shading out herbaceous growth. About 1 inch of litter covers the ground. The white pine shows little weevil injury. Just why the Scotch pine is ahead of the white on this plot and behind it on Plot 35 is not apparent unless the grouping of the white pine on Plot 35 was more stimulating to height growth than the 12 x 12 foot spacing on Plot 37. Compare with Plots 4, 34, 35, 36 and 56.

Plot 38. White pine and Douglas fir. Area .4 acre. Planted in the spring of 1903, spacing 5 x 5 feet, the two species alternating in the rows. The pine has grown faster than the fir and now averages 18 feet tall and 4.6 inches in diameter, while the fir averages 10 feet tall and 1.3 inches in diameter. The early growth of the fir was very slow. This may have been due to the stock not being hardy because many trees have been killed back and deformed. However, the species seems to recover from this and to send up a new leader without any apparent deformation of the stem. The fir has not developed evenly, individuals varying from 1 to 16 feet in height. Some of this irregularity has been caused by suppression by pine. Fir produces a very narrow compact crown while pine, when given sufficient room, produces a wide crown. The result of this is that the stand has just closed and both species have live limbs clear to the ground. The fir seems quite tolerant and shows a considerable tendency to push through the pine crowns. Side limbs on the pine were cut back to favor the fir in 1923 and more of this work will be done in the future. During the last 5 years the fir has shown a greatly increased height

*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

growth and may in time catch up with the pine. It has held its own with the pine better than did Norway spruce planted under about the same conditions on Plot 69.

On account of the differences in crown habit it would seem advisable either to plant the fir about 5 years before the pine with the same spacing or to plant the two species at the same time with a closer spacing.

Plot 39. White pine. Area .7 acre. Planted in the spring of 1903 with white pine and hardwoods, the latter forming 75% of the mixture. The spacing was originally 5 x 5 feet but the hardwoods have failed and the pine is now spaced 10 x 10 feet. The results of this wide spacing are not entirely satisfactory. The pine shows a 50% injury by weevil. The stand is just closing, the side branches are large and long and have died for only a few feet above ground. Heights average 17 feet and diameter, 4.6 inches. All birch was removed from the plot in 1924. It is somewhat difficult to predict what the final results will be but it looks as if these short, large boled trees would produce a heavy yield of inferior lumber. A thinning will not be needed for at least another 10 years. Compare with Plots 4 and 59 for other examples of wide spacing and with Plot 28 for close spacing.

Plot 40. Red pine. Area .9 acre. Planted in the spring of 1924 with 2 year seedlings, spaced 8 x 8 feet, under a dense cover made up of grey birch and scattered trees from a red oak experiment which was a failure because rodents kept the trees cut back. At the end of the first growing season less than 10% of the red pines had failed. The plan is to remove all hardwood cover for cordwood after about 5 years.

Plot 41. White pine and Norway spruce. Area .2 acre. Planted in the spring of 1906 with 2 year seedlings, spaced 5 x 6 feet, under light brush, the species alternating by rows. Fifty per cent of the pine and 20% of the spruce failed. The birch cover was thinned in 1919 and completely removed in 1924. Both the pine and the spruce have been badly weeviled, probably because the plot is very narrow and open to a road on one side. The spruce is also attacked by galls. The two species average about the same in height, 12 feet, but the pine averages 3.5 inches in diameter and the spruce only 1 inch. Spruce has shown a greatly increased height growth in the last 5 years. Neither species shows dead limbs and in general the plot is quite ragged and has not closed. It may be compared with Plot 69 where these two species were planted in the open and the pine suppressed practically all the spruce.

Plot 42. White pine and Norway spruce. Area 2.6 acres. Planted in the spring of 1906 with 2 year seedlings, spaced 5 x 6 feet, the two species alternating by rows. Blanks were filled in

1911 with 5 year white pine transplants. At the time of planting an overwood of pitch pine and hardwoods, which varied in density from heavy on the south end to very open on the north end, covered the area. One acre in the densest portion of the overwood at the south end was cleared in 1911. In 1919, hardwood sprouts from the cutting in 1911, which has overtopped the planted trees, were thinned to give the conifers more light. The plot is now about 75% stocked and is rather uneven. The pine averages 15 feet in height and 2 inches in diameter and the spruce 11 feet in height and 1 inch in diameter. Neither species show dead branches for over 2 feet above ground. Both have been heavily damaged by weevil but the spruce is less deformed by the injury than the pine. The spruce is also heavily infested with galls. The effect of the cover has been to hold back the pine more than the spruce allowing the latter to hold its own with the pine. During the last few years the spruce has increased height growth enormously. Comparison may be made with Plot 69 where these two species were planted in the open.

Plot 43. White pine and Norway spruce. Area 4.2 acres. Planted in the spring of 1905 with 2 year seedlings, spaced 5 x 6 feet, the two species alternating by rows, Blanks were filled with 5 year white pine transplants in 1911. A medium dense overwood, chiefly pitch pine, covered the entire plot. This was removed from the south end in 1923. Both species have grown more slowly than on Plot 42 on which the cover was removed at an earlier date. The pine averages 10 feet tall and the spruce 6 feet. However, weevil damage has been very slight for both species and while the trees are not as large as on Plot 42 they are of much better form. Compare with Plot 69.

Plot 44. White pine. Areas 3.1 acres. Planted in the spring of 1906 with white pine 2 year seedlings, pure on the west side and mixed with maple on the east side. Spacing 6 x 5 feet. The maple failed and blanks were filled in 1910 with 4 year white pine transplants. Failures were filled again in 1911 with 5 year white pine transplants. An overwood of pitch pine and grey birch, varying in density from nothing at the south end to moderately dense in the middle and on the north end, covers the area. Over 80% of the trees are present. In the open they average 14 feet tall and 4.5 inches in diameter and under the overwood, 10 feet tall and one inch in diameter. Only in a few places has the stand closed and live limbs extend to the ground. Herbaceous growth has not been shaded out. A little spruce occurs at the north end, evidently an extension of Plot 43. The most marked feature is the almost entire absence of weevil injury and the smallness of side branches on the portion of the plot under the overwood. A cover of pitch pine is less harmful than is grey birch because its branches are stiff and therefore do not whip the white

pine tops as badly as do those of the birch. Several barren areas (see page 104) occur on Plot 44.

Plot 45. Mountain pine. Area 4.6 acres. Planted in the spring of 1912 with mountain pine, spaced 6 x 6 feet. The stock proved to be the Mugho variety of mountain pine and has been sold for ornamental purposes (See note on Mugho pine under Plot 34). A few Corsican pines from a planting which was made in 1910 and which was almost a complete failure, are scattered over the plot. They have made fair growth but are open grown and bushy. Barren areas (see page 104) similar to those in Plot 44 occur in Plot 45.

Plot 46. White pine—Norway spruce—Jack pine. Area .7 acre. Planted in the spring of 1906 with 2 year seedlings of white pine and spruce, spaced 5 x 6 feet, and alternated by rows. In 1908 fail places were filled with Jack pine. The composition of the plot is now 50% Jack pine, 25% white pine and 25% spruce. Jack pine has grown faster than the other two species averaging 21 feet in height and 4 inches in diameter. The white pine averages 18 feet high and 4.5 inches in diameter and the spruce, 10 feet high and 1.5 inches in diameter. Both spruce and white pine show a small amount of damage by weevil and the former is often infested with galls. The stand is almost entirely closed but there is only a small amount of litter. Jack pine has dead branches extending for 8 feet above ground, and white pine for 5 feet. Spruce has no dead branches. For the first ten years the spruce grew quite slowly but since that time, except where it was heavily shaded, it has increased its height growth enormously, often making 2-3 feet a year. Under stiff competition Jack pine develops well, forming a straight bole and small side branches which die early. This plot demonstrates its value as a late filler, for which it compares favorably with Scotch pine. About 2 cords of birch were removed from the plot in 1919 and a final release cutting was made in 1924. Spruce trees completely covered by pine will be sold as Christmas trees. This plan will also be followed on Plots 42 and 43. Compare Jack pine on this plot with that on Plots 30 and 47 where this tree grew more or less in open stands. Compare the white pine and spruce with that on Plots 41, 42, 43 and 69.

Plot 47. Douglas fir—Jack pine—Norway spruce. Area .9 acre. Planted in the spring of 1903 with Douglas fir and several hardwoods mixed at random and spaced 5 x 5 feet. Practically all the hardwoods failed and blanks were filled in 1908 with Jack pine. The fir is all on the east side of the plot and with the Jack pine and some spruce planted at a latter date forms a fairly good stand. The west side contains a scattering of Jack pine and a volunteer growth of birch and other hardwoods. Some chestnut

from the early hardwood experiment still persists but is kept killed back by the blight. The west side should be used for another experiment. The fir has developed in all respects about as it did on Plot 38. The spruce, being much younger, is mostly overtopped. Jack pine has developed much as it did on Plot 30 where it was open grown, i.e., it produced long side branches and crooked boles. It is bearing cones prolifically and numerous seedlings up to 7 feet tall may be found in the openings. The stand on the west side has not closed sufficiently to shade out herbaceous growth and there is almost no needle litter.

Plot 48. Red oak and White pine. Area .9 acre. Planted in the spring of 1904 with oak 1 year seedlings and pine 2 year seedlings, spaced 6 x 6 feet, 4 rows of oak alternating with 2 rows of pine. Eighty-five per cent of the oak and 70% of the pine are living but 50% of the oak have been kept cut back by rodents. These trees were excluded in the measurements. Oaks not attacked by rodents have done better than the pines and are crowding the latter severely. Oak averages 20 feet in height and 2 inches in diameter and pine averages 18 feet in height and 4 inches in diameter. The best oak on the tract is to be found on this plot. About half the pines have been injured by weevil and are of poor form. The thrifty oaks have dead branches for a height of 10 feet, but dead branches on the pine do not extend over 2 feet above the ground. Most of the pine limbs are small. The stand, as a whole, has closed and most of the herbaceous growth, except brake ferns, has been shaded out. There is very little litter on the ground. Considerable birch in the mixture helps to make the canopy quite dense. This plot is in need of thinning to give the better oak and pine a chance. Compare with Plots 4 and 51.

Plot 49. Pitch pine. Area .9 acre. Planted in the spring of 1903 with 2 year transplants, spaced 5 x 5 feet. Over 90% of the original trees are still living (except on thinned sample plot described below) but the stand is not thrifty. Average height, 15 feet; diameter, 3 inches.

In 1921 students from the Yale School of Forestry laid off and measured two sample plots of 1/16 acre each and thinned one of them. The results of the counts and measurements for the unthinned plot were—number of trees, 131 or at the rate of 2,096 per acre; volume, 26 cu. ft.* of wood or 416 cu. ft. per acre: for the thinned plot—number of trees before thinning, 130 or 2,080 per acre; after thinning, 78 or 1,248 per acre: volume before thinning, 29.4 cu. ft. or 470.4 cu. ft. per acre; after thinning, 20.5 cu. ft. or 328 cu. ft. per acre. These sample plots will be remeasured and the thinned plot thinned again in 1926.

*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

The unthinned pitch pine on Plot 49 has apparently stagnated although the stand does not seem at all dense. Live crowns have been reduced to 1/8 the total height of the tree. Pitch pine seems fairly tolerant of shade of older pitch pine but it does not seem able to stand side crowding. On this plot all trees had an equal amount of growing space and have developed about equally with no marked differentiation into crown classes. On the south half of Plot 3 this species has grown under quite different conditions, more nearly approximating those in nature. The number of seedlings that started was very large and competition during the earlier years quite keen. The stronger individuals developed rapidly, suppressing the weaker trees, thereby obtaining more room for the development of their crowns.

On the sample plot thinned in 1921, crowns are deeper and the trees are generally healthier than on the remainder of the area. Compare Plot 49 with Plots 3, 22, 23 and 28.

Plot 50. Red oak. Area .9 acre. Originally an experiment with red oak but rodents kept the trees cut back so badly that the result is almost a total failure. An occasional individual has not been attacked and has made good growth but these are so scattering as to be worthless as a test of this species. A volunteer stand of birch and pitch pine has taken possession of the plot.

Plot 51. Red oak and White pine. Area .9 acre. Planted in the spring of 1904 with oak 1 year seedlings and pine 2 year seedlings, spaced 6 x 6 feet, two rows of oak alternating with one row of pine. Practically all the oak are present but 2/3 of them have been cut back by rodents. Those not cut back are ahead of the pine but are so scattering as to make the pine appear to be spaced 6 x 18 feet. The thrifty oak averages 19 feet in height and 2 inches in diameter, and the pine 17 feet in height and 5 inches in diameter. About 20% of the pine failed. Those living have been badly weeviled and are of poor form. They have closed in the rows but not between them. Herbaceous vegetation has not been killed out except directly under the pine and there is little litter on the ground. Compare with Plots 4 and 48.

Plot 52. White pine and Japanese red pine. Area .9 acre. Planted in the spring of 1910 with 2 year seedlings, spaced 6 x 6 feet, the two species alternating by rows. Loss in the Japanese red pine was heavy and blanks were filled about 1914 with white pine. The present stand is fully stocked and is 25% Japanese red and 75% white pine. Both species average 7 feet in height. Both have been weeviled, the white the more heavily than the other. The plot was thoroughly cleaned of birch in 1923. Crowns are just commencing to close, much herbaceous cover is still present and there is no litter on the ground. This plot is similar to Plot 5 and has received practically the same treatment except that the

leaders on the Japanese red pine have not been pruned back but left for comparison with Plot 5. Comparison may also be made with Plot 19.

Plot 53. White pine. Area .2 acre. Planted in the spring of 1905 with 2 year seedlings, spaced 5 x 5 feet. Blanks were filled in 1910 with three year transplants. All birch was removed by lopping in 1923. Several large pitch pine and clumps of birch held back or killed the white pine on part of the plot so that the stand is rather irregular and only about half the original number of trees is present. Dead branches extend for 4 feet above ground but are firm. Crowns have closed, resulting in a forest floor without vegetation and covered with 2 to 3 inches of needles. Fifty per cent of the trees have been damaged by weevil. Average height, 13 feet; diameter, 3.3 inches.

Plot 54. White pine and Japanese black pine. Area .9 acre. Planted in the spring of 1910 with 3 year seedlings of white pine and 2 year seedlings of Japanese black pine, spaced 6 x 6 feet, and alternating by rows. The Japanese species was apparently not hardy and 90% of it failed. Those living are only 2 feet tall and tend to have a prostrate habit. Twenty-five per cent of the white pine failed also so that the stand is only 40% stocked. The white pine has been heavily weeviled and is bushy and of poor form. It averages 7 feet in height. The plot was cleared of birch in 1923. Pitch pine is scattered over the plot but is not sufficiently dense to stimulate the white pine.

Plot 55. White pine. Area .9 acre. Planted in the spring of 1903 with 2 year seedlings from Maine, alternating in the rows with beech, spacing 6 x 6 feet. The beech failed and the experiment has become one of pure pine with a spacing of 8½ x 8½ feet. The stand is complete and is just closing. Lower limbs are just beginning to die and ground vegetation is almost completely shaded out. Average height, 17 feet; diameter, 4.5 inches. Fifty per cent of the trees have been injured by weevil. Diameter growth has been consistently large over the whole plot and the stand is thrifty, and in good condition except for weevil damage.

Plot 56. White pine and Scotch pine. Area .9 acre. Planted in the spring of 1903 with white pine 2 year seedlings and beech, spaced 6 x 6 feet, a solid row of beech alternating with a row of beech and pine mixed. In 1911 the beech was replaced with Scotch pine 3 year transplants. The white pine has made a large diameter growth averaging 4.5 inches, but a poor height growth, averaging only 17 feet. The Scotch pine, although 8 years younger, averages 16 feet in height and 3 inches in diameter. The mixture contains about 80% Scotch and 20% white pine. The stand has just closed and dead branches extend for 4 feet above ground. They are large and heavy on the white pine but short and slender

on the Scotch. Half the white pine has been damaged by weevil. Practically all ground cover has been shaded out and 2 to 3 inches of needles cover the ground. Compare with Plots 4, 34, 35, 36 and 37.

Plot 57. Red pine. Area .9 acre. Cleared of a scattered stand of large grey birches in the fall of 1923 and planted in the spring of 1924 with 2 year seedlings, spaced 8 x 8 feet. At the end of the first growing season less than 10% had failed. Compare with Plot 40 for a plantation of red pine made at the same time under heavy cover.

Plot 58. Black locust. Area 1.0 acre. Planted in the spring of 1903 with 1 year seedlings with various spacings. As far as growth is concerned this species has done better than any other used in the plantations, attaining a height of 35 feet and a diameter of 6 to 7 inches and reproducing itself prolifically. However, damage from the locust borer (See page 105) was so great that in the fall of 1923 the stand was removed for cordwood and the experiment abandoned. During the last growing season, sprouts have reached a height of 10 feet.

Plot 59. White pine. Area 1.0 acre. Planted partly in the spring of 1903 with white pine 2 year seedlings and partly in 1904 with white pine 3 year transplants alternating in the row with black birch and spaced 5 x 5 feet. A small portion of the plot was pure pine. The birch failed leaving the pine spaced about 7 x 7 feet on the average, although the spacing is somewhat irregular. Heights average 25 feet; diameters, 6 inches. Dead branches extend for 10 feet above ground and are moderately large and quite firm. Weevils have caused many crooked boles but in spite of this a good height growth has been maintained and the stand appears in good condition. Practically all herbaceous vegetation has been shaded out and 2 to 3 inches of needles cover the ground. This plot may be compared with Plot 39 for white pine with a wider spacing and with Plot 28 for a closer spacing.

In 1922 students from the Yale School of Forestry laid off two sample plots of ¼ acre each. One of these was thinned and the other left as a check. Measurements and counts were as follows: check plot, number of trees, 187 or at the rate of 748 per acre; volume, 219.1 cu. ft.* of wood or 876.4 cu. ft. per acre. Thinned plot, number of trees before thinning, 216 or 864 per acre; after thinning, 158 trees or 632 per acre: volume before thinning, 249.9 cu. ft. of wood or 999.6 cu. ft. per acre; after thinning 208.0 cu. ft. or 832 cu. ft. per acre. Both plots will be remeasured and the thinned plot will be thinned again in 1927.

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*Volumes computed from Table 27, Bulletin 13, U. S. D. A., revised and extended to cover the sizes of trees found on this plot.

Plot 60. White pine. Area 2.1 acres. Planted in the spring of 1905, together with Plot 68, with 2 year seedlings, 3 year transplants and wild seedlings from Stafford. Spacing was 5 x 5 and 6 x 6 feet, and trees were set in old furrows and on mounds between. Both plots are the same in all respects and are described together. Both are in excellent condition. Trees average 20 feet in height and 4 inches in diameter. Weevil damage has been comparatively slight and little damage seems to have been done until the trees were 12 feet or more in height. Dead branches extend for 10 feet above ground and are small but quite firm. Herbaceous vegetation has been shaded out and several inches of needles cover the ground. Competition has not been too keen but a thinning is needed to prevent the stand becoming stagnated. These two plots contain the best growth of white pine on the tract.

Plot 61. White pine. Area 2.2 acres. Planted in the spring of 1913 with 5 year transplants, spaced 5 x 6 feet. A few clumps of chestnut sprouts still persist from a previous experiment. A moderately dense stand of grey birch covered the pine until 1923 when it was entirely removed by lopping. This cover does not seem to have been sufficiently dense to protect the pine from weevil as 30 to 40% of the trees have been damaged. Practically the entire planting survives. The stand has not yet closed, and bunch grass and other herbaceous growth still persists. The pine averages 9 feet in height and, in competition with birch sprouts that have come up since the cutting in 1923, should make a good height growth and produce only small side branches.

Plot 62. White pine and Scotch pine. Area 5.1 acres. Planted in the spring of 1907 with 2 year seedlings of white pine, spaced 5 x 5 feet. In 1922 a fire destroyed about 50% of the plot facing Plots 61–64 (measurements and counts exclude this burn). The stand has just closed and some herbaceous cover still persists. Plot was cleaned of birch in 1919. Weevil damage has been quite heavy averaging 35%. Average height, 17 feet; diameter, 3 inches.

The burn was replanted in the spring of 1924 with white and Scotch pine 2 year seedlings. The season was dry, the fire had reduced the tract to a barren sand plain, the stock was small and a very heavy loss resulted during the first growing season.

Plot 63. Red pine and White pine. Area 2.6 acres. Planted in 1917. The species were planted alternately 6 feet apart, in rows 10 feet apart with the idea that at some later date Scotch pine or some other species would be used as a late filler. This has not yet been done. The plot was cleaned of a heavy cover of birch in the spring of 1923. About 95% of the original trees are living. The red pine appears more thrifty and of better form than the white because the latter has been severely injured by weevil. Both species average 5.5 feet tall. The stand is just closing in the rows but not between.

Plot 64. Scotch pine. Area, 1.3 acres. Planted in the spring of 1910 with 2 year seedlings, spaced 6 x 6 feet. Subsequent loss has been rather heavy, due partly to failures at the time of planting and partly to suppression by birch. The birch was thinned in 1923 and completely removed by lopping in 1924. A number of medium sized pitch pines were girdled in 1924. This should be the final release cutting as the Scotch pine can probably take care of itself from now on. The stand is just closing but is rather ragged. Trees average 15 feet in height and 2.5 inches in diameter, and have dead branches for 3 feet above ground. Herbaceous cover still persists and there is little litter on the ground. The extreme intolerance of Scotch pine and the effect of cover on this species are well illustrated.

Plot 65. Red pine. Area .8 acre. Planted in the spring of 1917 with red pine, spaced 5 x 5 feet. There were practically no failures and the stand is quite thrifty except on a few sterile spots (described under Plot 16). A small fire in 1922 destroyed about 75 trees near Plot 66. A heavy birch cover was removed in 1923 but the red pine does not seem to have been held back to any extent by its shade. A few medium sized pitch pines were girdled in the fall of 1924, thus removing the last of the cover from the red pine.

Plot 66. Western yellow (bull) pine. Area 1.5 acres. Planted in the spring of 1908 with 2 year seedlings, spaced 5 x 5 feet. This plot is similar in all respect to Plot 6 except that the blanks, which amount to about 45%, have not been filled. The trees average 11 feet tall, somewhat larger than on Plot 6 but in general development has been similar to that on Plot 6. Bull pine seems to be quite intolerant. Individuals growing in the shade are stunted and, even when growing in the open, the lower branches die from the shade of those above. A ground fire burned over a small area in this plot in 1922 killing the bull pine completely. This species appears to be at least as susceptible to injury by ground fires as red pine.

Plot 67. Native pitch pine. Area .1 acre. No treatment.

Plot 68. White pine. Area 4.3 acres. (See Plot 60.)

Plot 69. White pine and Norway spruce. Area 3.6 acres. Planted in the spring of 1905 with 2 year seedlings, spaced 5 x 5 feet, the two species alternating in the row. Ninety per cent of the pine and 60% of the spruce lived but the pine has grown much the faster of the two and has overtopped about 90% of the spruce completely, making the plot in effect one of pure pine with a spacing of about 7 x 7 feet over an understory of spruce. In a few instances the spruce has grown rapidly and will probably catch up to the pine. The latter has long, heavy side branches which have died for 8 feet above ground but still persist. Weevils have

injured about 30% of the pines. Average sizes: pine, 22 feet tall and 4.5 inches in diameter; spruce, 5 feet tall. Overtopped spruce trees are being removed and sold for Christmas trees as fast as a market can be found for them. This plot demonstrates the fact that it is not feasible to plant spruce and pine in the open at the same time, as the pine grows much faster and completely overtops the spruce. Compare with Plots 41, 42 and 43 where an overwood has held back the pine more than the spruce, enabling the latter to hold its own with the pine. In 1913 a fire burned over about an acre in Plot 69 along the East Granby highway (See Plot 69a).

Plot 69a. Red pine. Area about 1.0 acre. Planted in the fall of 1920 with 3 year transplants, spaced 6 x 6 feet, under a scattering cover of grey birch as a test of fall planting. The experiment was a complete success. Ninety-five per cent of the trees are still living and the average height is 2½ feet. A few spruce and pine from the 1905 planting are scattered over the plot. All hardwood growth was removed by lopping in the fall of 1924.

Plot 70. Austrian pine. Planted in the spring of 1908 with 2 year seedlings, spaced 6 x 6 feet. The trees suffered heavily from drought and winter injury and at present less than 25% of the original planting is present. Heights vary from 2 to 10 feet and average about 3 feet. Most of the trees have crooked boles and, in general, appear sickly and show poor development. The plot was thoroughly cleaned by lopping back the hardwoods in 1923.

Conclusions.

Seeding versus planting. In general it may be said that experiments in regeneration by seeding were not successful. The seed of many species, both coniferous and hardwood, were sown by various methods but results were so poor that regeneration by seeding was soon abandoned. Even during the most favorable seasons the moisture conditions in the surface soil are very poor and it is often several years before any vegetation appears on land abandoned for cultivation. Grey birch, which usually reproduces quite prolifically on bare soil, does not come in readily on bare areas in this region. Planting, on the other hand has been quite successful. When this method has failed, the cause can usually be traced to using unsuitable species or to some other reason.

Hardwoods versus conifers. Of the many experiments with hardwood species, only three were successful enough to warrant comment. Red oak, black locust and chestnut seemed to thrive on poor soil when not attacked by enemies. Unfortunately all three species have been subject to animal, insect or fungous injury and are almost complete failures. The other hardwoods used have either died out completely or are represented by a few

stunted specimens. The conifers, on the other hand, have done well. Some have done better than others but only in one or two cases can an experiment with conifers be called a complete failure. From this it is apparent that the tract is far better suited to coniferous than to hardwood growth, mainly because the former are far less exacting in their moisture requirements than the latter.

Conifers. Three species stand out conspicuously above all others used. They are red, white and Scotch pine. Of these Scotch pine has grown the fastest during the juvenile period, i.e., the first 20 years. However, it is an European species and has not been brought to maturity in this country as a timber tree. There is, therefore, some uncertainty as to just how it will develop between the twentieth year and the time it is ready to cut. Should later development prove satisfactory, its value for planting on poor soils in this country may be very great on account of its rapid growth. Its worst fault seems to be a tendency to form crooked boles. One of the greatest values is as a filler in older plantations of other species where failures have occurred. The wood is somewhat similar to that of red pine and is a little harder and heavier than that of white pine.

The growth of red and white pine is about the same. White pine is a well-known species and its wood is very valuable, more so than that of red pine, although, where they grow naturally together, both species are marketed as white pine. Red pine has no serious enemies. Its form is normally very good and it prunes itself better than white pine under the same conditions. The latter has several enemies, the worst of which in this region is the weevil. This insect causes a large percentage of the trees to form crooked boles which yield inferior lumber. For these reasons the red pine is considered the better of the two species.

Norway spruce, another European species, has done very well when planted under shade sufficiently dense to act as a nurse but not heavy enough to suppress the trees. As in the case of Scotch pine, there are no stands old enough to furnish data on what its later development will be.

Jack pine, which grows naturally on very poor soil in the Lake States, has not done well in pure stands where it forms crooked boles and long side branches. When used as a filler in older stands where it is obliged to grow rapidly in order to survive it does well, having much better form than when grown pure.

Western yellow (bull) pine is not recommended for this kind of site. It has grown slowly and is subject to a fungous disease which threatens to kill out the species here.

Two other European pines, Austrian and Corsican, have not proved satisfactory. In one instance Austrian pine did fairly well but in general losses with both species were heavy at the time of planting and the experiments with them are failures.

Pitch pine has proved as unsatisfactory as it is when it grows naturally. Its form is not good, its growth is slow and on the whole it may be called a worthless species in this region.

Of the two Japanese pines used, the Japanese black was a total failure because it was not hardy. The Japanese red pine shows considerable promise if handled properly. It has a strong tendency when quite young to divide at the base into several stems and form a bushy tree. When severely crowded, however, this species will normally produce only one stem and in such cases the trees make an excellent height growth.

The value of Douglas fir on sandy soil is questionable. The development of this species is exceedingly variable, some individuals having done very well while others are much stunted. During the last five years this tree has shown up much better than it did previously.

The European larch is another tree which varies greatly in growth, some individuals having equalled the Scotch pine in size while others are mere shrubs. Its value on poor soil is probably small.

White spruce has been used too recently to furnish any data on how it will develop.

The other conifers found on the tract, two species of fir and one of arbor-vitae, are too few in numbers to merit comment.

Hardwoods. Only three of the hardwoods used need mention. They are red oak, black locust and chestnut. When not attacked by rodents red oak makes a height growth equal to white pine and is of good form, indicating that this species is adapted to poor soils. However, rabbits kept so many trees cut back that the stands are open and the experiments are failures. Without exception, black locust made the best growth of any species used on the tract but the trees were so completely mined by the locust borer that the plantation had to be abandoned. Chestnut once grew naturally on the tract. It is difficult to say what the results of artificial regeneration of this species might have been. The fact that much chestnut still persists, even after being killed back repeatedly by the blight, indicates that this tree might have been profitably grown on this site.

Other hardwoods used, but which were complete failures, were white oak, green ash,* tulip,* black birch, hard maple,* beech, catalpa, cotton wood, white ash and hickory.*

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*No trees of these species were found in the 1924 survey.

List of Species Used on Experimental Plots.

Following is a list giving the common and scientific names and the plot locations of the species used in the experiments.

White pine; *Pinus strobus*, L.*
Plot 2, 4, 5, 6, 7, 11, 12, 15, 16, 17, 20, 21, 22, 24, 25, 26, 27, 28, 29, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 46, 48, 51, 52, 53, 54, 55, 56, 59, 60, 61, 62, 63, 68, 69.

Red pine; *Pinus resinosa*, Ait.
Plot 8a, 16, 17, 22, 24, 40, 57, 63, 65, 69a.

Scotch pine; *Pinus sylvestris*, L.
Plot 1, 4, 14, 17, 20, 21, 23, 31, 34, 35, 36, 37, 56, 62, 64.

Pitch pine; *Pinus rigida*, Mill.*
Plot 3, 49.

Austrian pine; *Pinus Laricio* var. *austriaca*, Endl.
Plot 1, 24, 70.

Corsican pine; *Pinus Laricio*, Poir.
Plot 45.

Jack pine; *Pinus divaricata*, Du Mont de Cours.
Plot 30, 46, 47.

Western yellow pine; *Pinus ponderosa*, Laws.
Plot 6, 66.

Japanese red pine; *Pinus densiflora*, Sieb & Zucc.
Plot 1, 5, 16, 19, 52.

Japanese black pine; *Pinus Thunbergii*, Parl.
Plot 54.

Mountain pine; *Pinus montana*, Mill.
Plot 34, 45.

Mugho pine; *Pinus montana* var. *Mughus*, Willk.
Plot 17, 34, 45.

Douglas fir; *Pseudotsuga Douglasii*, Carr.
Plot 1, 17, 38, 47.

Balsam fir; *Abies balsamea*, Poir.
Plot 13, 32.

White fir; *Abies concolor*, Lindl. & Gord.
Plot 17.

European larch; *Larix europea*, de C.
Plot 1, 17.

Arbor-vitae; *Thuya* sp.
Plot 17.

Norway spruce; *Picea excelsa*, L.
Plot 8a, 8b, 10, 32, 41, 42, 43, 44, 46, 47, 69.

White spruce; *Picea canadensis*, Mill.
Plot 18, 32.

Red oak; *Quercus rubra*, L.
Plot 4, 17, 40, 48, 50, 51.

White oak; *Quercus alba*, L.*
Plot 17.

White ash; *Fraxinus americana*, L.
Plot 17.

Black birch; *Betula lenta*, L.
Plot 59.

Grey birch; *Betula populifolia*, Marsh.*
on nearly every plot.

Beech; *Fagus americana*, Sweet.
Plot 20, 21, 55, 56, 57.

Catalpa; *Catalpa* sp.
Plot 5.

Cottonwood; *Populus deltoides*, Marsh.
Plot 6.

Basswood; *Tilia americana*, L.
Plot 47.

Chestnut; *Castanea dentata*, Borkh.*
Plot 7, 8a, 8b, 27, 57, 61, 63, 64, 65, 66.

Black locust; *Robinia Pseudacacia*, L.
Plot 17, 19, 57, 58, 59.

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*Found growing naturally, as well as where used in experiments.

BULLETIN 263 DECEMBER, 1924

Connecticut Agricultural Experiment Station
New Haven, Connecticut

SECOND REPORT

OF THE

TREE PROTECTION EXAMINING BOARD

W. E. BRITTON, Entomologist
G. P. CLINTON, Botanist
W. O. FILLEY, Forester

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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December, 1924.

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ANNOUNCEMENT.

The Tree Protection Examining Board created by the General Assembly of 1919 (see Public Acts of 1919, Chapter 181), has adopted this as its Second Report.

ILLUSTRATIONS.

The illustrations in this report are from photographs from the following sources: Plate XV, a, by Mr. Harry B. Kirk; Plates IX, X, b, XI, a, and XIV, d, by Mr. B. H. Walden; Plates X, a, XI, c and d, XIV, a, XIV, d, and XVI, by Mr. W. O. Filley; Plates XII, XIII, XIV, b and c, XV, b and c, by Dr. W. E. Britton.

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SECOND REPORT

OF THE

Tree Protection Examining Board

Covering the Three Years Ending June 30, 1924

The first report of the Tree Protection Examining Board was issued in 1921 as Bulletin 231, and was included in the Annual Report of the Station for that year, pages 339-350. It contained an account of the activities of the Board including the law, rules and regulations, sample examination questions, forms of certificates, institute program, financial statement, list of firms and individuals receiving certificates, and a general discussion explaining the reasons for legislation, and warning tree owners to employ qualified men for their tree work and promising to investigate complaints.

The Station is often asked who is qualified for this work, and since no list had been printed since 1921, a revised list was published, April 25, 1924, as Bulletin of Immediate Information, No. 35, entitled, "Tree Workers Holding Connecticut Certificates." As this leaflet does not contain any account of the other activities of the Board, the present report has been made complete for the period which it covers. Sections on tree surgery and on the common insect and fungous pests of shade trees have also been added as a source of information to tree workers and tree owners.

The members of the Board feel that the legislation on this subject enacted in Connecticut in 1919, was fully justified by the conditions then existing, and believe that, on account of this legislation, these conditions have since greatly improved. Moreover, the Board has received from several other States requests for copies of the Connecticut law, regulations, and examination and certificate forms, with the statement that similar legislation was contemplated in those states. The law and regulations follow:

AN ACT CONCERNING THE IMPROVEMENT, PROTECTION OR PRESERVATION OF FRUIT, SHADE OR ORNAMENTAL TREES.

Chapter 181. Public Acts of 1919. (In effect July 1, 1919.)

SECTION 1. No person, firm or corporation shall advertise, solicit or contract to improve the condition of fruit, shade, forest or ornamental trees, by pruning, trimming or filling cavities, or to protect such trees from damage by insects or disease, either by spraying or any other method, without having secured a certificate as specified in section two of this act; and

any person, firm or corporation failing to comply with the terms of this act shall be fined not more than one hundred dollars; provided any person may improve or protect any tree on his own premises or on the property of his employer or on any property within the limits of the town of which he is a legal resident, without securing such a certificate.

SECTION 2. The botanist, entomologist and forester of the Connecticut Agricultural Experiment Station shall constitute a board which shall, upon application from any person, firm or corporation, examine the qualifications of the applicant to improve, protect or preserve fruit, shade, ornamental or forest trees, and if satisfied that the applicant is qualified, may issue a certificate so stating; which certificate shall be valid for one year from the date of its issue, unless sooner revoked as provided in section three of this act, and may be renewed by the board for succeeding years without further examination, upon payment of the fee hereinafter required, provided any person, firm or corporation receiving such certificate shall be responsible for the acts of all employees in the performance of such work.

SECTION 3. Said board shall prepare all necessary forms and prescribe all rules and regulations governing examinations, and any certificate issued under the provisions of this act may be revoked by it upon proof that improper methods have been used or for other sufficient cause.

SECTION 4. Each applicant for an examination shall pay a fee of five dollars in advance, and a fee of two dollars for each certificate or renewal issued; which fees may be expended by the board for any expense incurred by it in making examinations or issuing certificates, and an account of all receipts and expenditures under this act shall be rendered annually to the state comptroller.

As the law provides that this Board shall consist of the botanist, entomologist and forester of the Station, the Board was organized by electing as Chairman, W. E. Britton, Entomologist, as Vice-Chairman, G. P. Clinton, Botanist, and as Secretary-Treasurer, W. O. Filley, Forester. The following rules and regulations have since been adopted by the Board:

EXAMINATION RULES AND REGULATIONS.

I. Each person, firm or corporation required to secure a certificate under Chapter 181, Public Acts of 1919, shall be examined as follows: When a firm is under control of one person who is solely responsible for the contracts, methods and oversight of each piece of work, this person alone may be required to pass the examination, but when more than one person is responsible for the methods of work and oversight of same, each shall be required to take the examination. When foremen or others are given complete charge of recommending and applying treatments, they shall also be required to take the examination, in so far as it relates to their work. The Examining Board shall decide who shall be required to take the examination.

II. Unless otherwise arranged, candidates for certificates shall appear for examination at the Connecticut Agricultural Experiment Station, at New Haven, at such times as shall be designated by the Board.

III. Examinations may be oral, written, or both, as shall be determined by the Examining Board, and, in general, shall cover tree species, tree life and growth; diseases and insect pests of trees, with treatment for same; pruning and tree surgery.

IV. Candidates prior to the time of examination shall furnish a typewritten statement of their qualifications as follows:

1. General education.
2. Special training for tree protection work.
3. Experience in tree protection work. The latter shall include
   (a) Place of business, name of firm and position now held.
   (b) Previous positions held.
   (c) Total length of experience.
   (d) Contracts now under way or completed during the past 12 months.

In addition three or more recommendations as to reliability and efficiency shall be furnished; and where typed or printed forms of contracts, regulations, etc., are used, these shall also be supplied, or if not available, statements shall be made concerning the same.

V. If satisfied with the qualifications of the applicant, the Board will issue a certificate good for the succeeding twelve months (unless revoked for cause), then to be renewed upon application under such conditions as the Examining Board may require in each case.

VI. Upon evidence of unfitness in training or improper business methods, the Examining Board may refuse to issue a certificate or cancel one tbat has been issued. Complaints may be made to the Board on these points, and if deemed desirable by the Board, private hearings of the interested parties shall be held.

Renewal of Certificates.

The provision of Section 4, Chapter 181, Public Acts of 1919, regarding renewal of certificates shall be construed by this Board as meaning a continuous possession of a certificate and not an attempt to obtain a new certificate after a long period during which the old certificate has lapsed. The following rules are hereby adopted:

1. The secretary shall notify each certificate holder at least two weeks before his certificate expires, and again two weeks after date of expiration, unless previously renewed. If a certificate has not been renewed one month after date of expiration it then becomes invalid and the holder shall be notified to that effect.

2. An invalid certificate may be revalidated at the discretion of the Board for the full renewal period or the unexpired portion thereof, if request for such action is received within three years from expiration date and if all renewal fees for the intervening period, as well as the renewal period, are paid in full.

3. If application is made on or before the expiration date of a certificate, a demit or respite covering a period of three years may be issued without charge, entitling the holder to obtain a renewal certificate for one year on payment of the statutory fee of $2.00.

4. If after three years with or without a demit a certificate has not been renewed, a new application with a fee of $5.00 shall be necessary and another examination may be required by the Board.

Number of Certificates Issued

In all, 109 certificates have been issued by the Board since the law became effective. Of this number, 80 are now in force and 29 have been canceled; three by death, four by changes in business, nine by removal from the state and 13 were not renewed. The following list contains the names of individuals and firms now holding certificates which are in force:

Firms and Individuals Holding Certificates

Name	Address	Cert. No.	Certificate Expires
Armstrong Tree Service, Ltd.			
Armstrong, Newton G.	Poughkeepsie, N. Y.	86	May 25, 1925
Parmelee, Leland E.	Poughkeepsie, N. Y.	89	July 23, 1925
Baldwin, Thos. J.	P. O. Box 176, Guilford, Conn.	21	July 15, 1925
Bartlett Tree Expert Co., F. A. (F. A. Bartlett)	Stamford, Conn.	10	July 15, 1925
*Barton, Robert	P. O. Box 57, Hamden, Conn.	66	Dec. 18, 1924
Beaupain & Saunders (Henry F. Beaupain)	So. Norwalk, Conn.	27	Aug. 12, 1925
*Bertolf Brothers (August C. Bertolf)	Sound Beach, Conn.	24	July 29, 1925
Brown, Edgar M.	211 Sisson Ave., Hartford, Conn.	52	June 6, 1925
Calverley, Arthur	763 Campbell Ave., West Haven, Conn.	97	Mar. 31, 1925
Cardarelli, Emilio J.	Cromwell, Conn.	57	Feb. 28, 1925
Clark, Harry E.	Middlebury, Conn.	72	Mar. 8, 1925
Clark, Wyllis S.	New Canaan, Conn.	20	July 15, 1925
Clyne, G. A.	73 Canal St., Waterbury, Conn.	5	July 1, 1925
Condon Co., Maurice L. (Maurice L. Condon)	Lake Mahopac, N.Y.	46	Feb. 2, 1925
Cromie, George A.	18 Compton St., New Haven, Conn.	88	May 25, 1925
Davey Tree Expert Company	Kent, Ohio.		
Baldwin, H. E.	General Delivery, Norwich, Conn.	91	July 23, 1925
Gammie, Peter	P. O. Box 423, Stamford, Conn.	60	May 26, 1925
Grove, D. Q.	Kent, Ohio	87	May 25, 1925
Landis, Ray E.	28 Smith St., Danbury, Conn.	108	May 15, 1925
Liming, O. N.	General Delivery, Stonington, Conn.	102	May 8, 1925
Tuomey, W. W.	General Delivery, South Manchester, Conn.	109	June 15, 1925
†Desmond, Thomas H.	Simsbury, Conn.	50	April 4, 1925
DeWolfe, John C. G.	85 Medford St., Medford, Mass.	80	Aug. 7, 1925
Dunham, L. N.	45 Park Terrace, New Britain, Conn.	104	May 8, 1925
Easton, Clifford H.	P. O. Box No. 1, Scarborough, N.Y.	53	June 16, 1925
*Elm City Nursery Co., J. L. Donnelly,	Box 1588, New Haven, Conn.	105	May 12, 1925
*Ernst, Otto F.	Norwich, Conn.	79	July 14, 1925
Fertsch, Ross L.	P. O. Box 220, Newburgh, N. Y.	84	April 4, 1925
Galligan, Clarence W.	15 Admiral Street, Allingtown, Conn.	74	June 28, 1925

* Is also a nurseryman.
† *Is also a landscape architect.*

FIRMS AND INDIVIDUALS HOLDING CERTIFICATES—*Continued*

Name	Address	Cert. No.	Certificate Expires
Gibbs, R. M.	33 Fairfield Street, Pittsfield, Mass.	83	April 4, 1925
Gilbert, J. E.	376 George Street, New Haven, Conn.	61	May 26, 1925
†Goodwin Associates, James L., James L. Goodwin	750 Main St., Hartford, Conn.	39	Nov. 26, 1925
Graf, Albert H.	P. O. Box 87, Bardonia, N. Y.	67	Dec. 18, 1924
Grovit, Albert	986 Whalley Ave., New Haven, Conn.	85	April 6, 1925
Gustafson, Harry A.	P. O. Box 81, Watertown, Conn.	96	Mar. 25, 1925
Hartford Forestry Company			
Hansling, Philip, Sr.	65 Sherman Street,	17	July 15, 1925
Hansling, Philip, Jr.	Hartford, Conn.	16	July 15, 1925
Herthal, G. F.	228 Bunnell Street, Bridgeport, Conn.	25	July 29, 1925
Herthal, Gus., Jr.	228 Bunnell St., Bridgeport, Conn.	36	Sept. 17, 1925
Hollister, S. P.	Conn. Agr. College, Storrs, Conn.	47	Mar. 21, 1925
Horlacher, John J.	197 Thomas Street, West Haven, Conn.	103	May 8, 1925
*Hunt & Co., W. W., (W. A. Wright)	167 Blue Hills Ave., Hartford, Conn.	33	Sept. 17, 1925
Kellner, Arthur H.	7 Grove St., South Norwalk, Conn.	26	Aug. 12, 1925
*Kellner, Herman H.	Danbury, Conn.	101	April 1, 1925
*Kelley, James J.	New Canaan, Conn.	19	July 15, 1925
Landscape Foresters, Ltd. (C. E. Mager)	52 Vanderbilt Ave., New York City	32	Sept. 17, 1925
*†Mallett Co., G. A., (George A. Mallett)	95 Catherine St., Bridgeport, Conn.	11	July 15, 1925
Maynard, Eugene	61 Coit St., New London, Conn.	94	Feb. 6, 1925
McLaughlin & Carberry			
Carberry, Joseph V.	Sharon, Conn.	78	July 9, 1925
McLaughlin, J. A.	Sharon, Conn.	77	July 9, 1925
Meader Co., L. H. (Lewis H. Meader)	75 Westminster St., Providence, R. I.	31	Sept. 17, 1925
*Millane Tree Expert Co., (Neal A. Millane)	Middletown, Conn.	1	July 1, 1925
Morris, Harry H.	9 Winthrop Place, Danbury, Conn.	40	Nov. 6, 1925
Munson-Whitaker Co. (Robert O'Shea).	1 Washington St., Boston, Mass.	42	Nov. 25, 1925
Murphy, Allen L.	Bethel, Conn.	106	May 15, 1925
Old Colony Forestry Co. (Thomas J. McGinnis)	415 Savin Ave., West Haven, Conn.	4	July 1, 1925
O'Gara, Charles E.	696 Dixwell Ave., New Haven, Conn.	110	Aug. 28, 1925
Pauley Tree Expert Co., (George A. Pauley)	New Canaan, Conn.	22	July 29, 1925

* Is also a nurseryman.
† Is also a landscape architect.

Firms and Individuals Holding Certificates—*Concluded*

Name	Address	Cert. No.	Certificate Expires
Perry, Lewis	Southington, Conn.	95	Feb. 6, 1925
Plumb, C. K. & J. C. (C. K. Plumb)	New Canaan, Conn.	100	Mar. 31, 1925
Pool, William H.	47 Sheffield Ave., Roslindale, Mass.	63	Oct. 10, 1925
Rice, Ralph S.	71 Howard Avenue, New Haven, Conn.	69	Dec. 18, 1924
Rich, Nehemiah L.	101 Warren Street, Stamford, Conn.	3	July 1, 1925
*Rockfall Nursery Co., (Philip Marotta)	Rockfall, Conn.	71	Mar. 8, 1925
Rottenberg, Julius	Newington Gardens, Newington Jct., Conn.	93	Jan. 9, 1925
Royal Forestry Co. (Charles Vallett)	124 Division St., Waterbury, Conn.	62	Aug. 5, 1925
*Schoonman, W. J.	New London, Conn.	6	July 1, 1925
Shaw, Walter	494 Blake St., Westville, Conn.	55	June 16, 1925
*Sierman, C. H.	2291 Albany Ave., West Hartford, Conn.	8	July 1, 1925
*Steck, Harold W.	Newtown, Conn.	92	Jan. 10, 1925
Szirbik, George	77 East Ramsdell St., Westville, Conn.	111	Aug. 28, 1925
*van Heinigen, Jacob C.	South Wilton, Conn.	48	April 4, 1925
van Kleef, Marinus	Bridgewater, Conn.	75	July 4, 1925
*Van Wilgen Company Van Wilgen, A. C.	71 Main St.,	99	Mar. 31, 1925
Van Wilgen, W. C.	Branford, Conn.	98	Mar. 31, 1925
*Verkade, H.	Corner Crocker St. and Lower Boulevard, New London, Conn.	18	July 15, 1925
Wilcox, Reginald C.	Essex, Conn.	30	Sept. 17, 1925
Wright, John L.	P. O. Box 593, Putnam, Conn.	43	Nov. 25, 1925

* Is also a nurseryman.

Examinations

The law provides that the fee of $5.00 shall be paid in advance. The form of application now in use is as follows:

> Tree Protection Examining Board,
> Box 1106, New Haven, Conn.
>
> Gentlemen:—
>
> I hereby apply for a certificate as provided in Chapter 181, Public Acts of 1919, to be issued in the name of
>
> ....
>
> Enclosed is examination fee of $5.00 required by law.
>
> ....
> Signature of Applicant
>
> ....
> Business Address

It has been the practice of the Board to hold an examination only when there were enough applicants to warrant one, rather than to set a special date for each applicant, and it has usually been possible to examine three or more candidates at one time. There have been occasional requests for examination by mail, but as a matter of policy, the Board has insisted on candidates appearing before it in person.

Since the last report, 16 examinations have been held as follows:

In 1921—July 26, October 3, December 19.
In 1922—March 9, May 18, June 26, October 27.
In 1923—April 2, May 25, July 23, November 26.
In 1924—February 5, March 25, May 2, June 6, August 28.

Fifty-three candidates presented themselves. Of this number, 48 were granted certificates without condition, three were requested to take a second examination, one was refused a certificate, and one passed the examination but decided he did not need a certificate. Fifty-one certificates were issued during the period covered, making a total of 109 certificates issued during the first five years of the Board's existence.

Form of Certificates

The form of the regular certificate adopted and used by the Board is as follows:

CERTIFICATE

FROM

Tree Protection Examining Board

STATE OF CONNECTICUT

This is to Certify that ______________________________

of ______________________ has been duly examined in compliance with the provisions of Chapter 181, Public Acts of 1919, and is considered qualified to conduct the business of protecting trees.

No.	.... Entomologist, *Chairman*	Examining Board
Date	.... Botanist, *Vice-Chairman*	
Expires	.... Forester, *Sec'y-Treas.*	

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONNECTICUT

At the expiration of the regular certificate, if the fee of two dollars ($2.00) has been paid, a renewal certificate is issued in the following form:

RENEWAL CERTIFICATE

FROM

Tree Protection Examining Board

STATE OF CONNECTICUT

This is to Certify that Certificate No.....was issued by this Board on..................to..........................
of...................., as provided by Chapter 181, Public Acts of 1919, and said certificate is hereby renewed for one year from................................

........Renewal ....*Entomologist, Chairman*

Expires........... ....*Botanist, Vice-Chairman*

Issued............ ....*Forester, Sec'y-Treas.*

CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONNECTICUT

To show that men are working under a valid certificate issued by the Board, a small card was furnished for each foreman employed by a firm or an individual. The form of this card is shown below:

State of Connecticut
TREE PROTECTION EXAMINING BOARD

THE BEARER
is working under supervision of and is responsible to

....

of...............................Conn.,

to whom this board has issued Certificate No....as provided by Chapter 181, Public Acts of 1919. Said certificate expires........

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION ....
NEW HAVEN, CONN. *Secretary*

Institutes for Instruction

The early examinations, as well as some of the more recent ones, have shown that many of the tree men are not well versed in the life processes and care of trees. Consequently, early in the first year after the law was passed, an institute of instruction was held at the Station at which the various phases of tree life and growth were discussed. The results were such that the Board has, in each of the years 1922, 1923 and 1924, conducted a one-day institute for this purpose, in some cases at the request of the tree workers. In all, four institutes have been held, the program of the first being given in the first Report of the Board. The attendance has varied between 50 and 100, and deep interest has been shown. The program and date of each of the other institutes are given below:

February 21, 1922

10.00 A.M. The Living Tree (Illustrated), by Dr. George E. Nichols, Assistant Professor of Botany in Yale University, New Haven, Conn.; The Pruning and Spraying of Fruit Trees, by Prof. Sherman P. Hollister, Assistant Professor of Pomology, Connecticut Agricultural College, Storrs, Conn.; Effects of Smoke, Gases and Electricity Upon Trees, by Prof. J. W. Toumey, Dean School of Forestry, Yale University, New Haven, Conn.; Observations on Oil Injury to Trees, by Dr. E. P. Felt, State Entomologist, Albany, New York. 12.00, Recess for luncheon. 1.30 P. M. Pruning and Cavity Work as Applied to Shade Trees (Illustrated), by J. Franklin Collins, Forest Pathologist, U. S. Dept. of Agriculture, Brown University, Providence, R.I.; Discussion, led by Dr. George E. Stone, Amherst, Mass.; Modern Methods of Tree Surgery (Demonstration), by F. A. Bartlett, Bartlett Tree Expert Company, Stamford, Conn.; Some Common Insect Pests of Shade Trees (Illustrated), by Dr. E. P. Felt, State Entomologist, Albany, New York; Report on work of Tree Protection Examining Board, by W. O. Filley, Forester, Connecticut Agricultural Experiment Station, New Haven, Conn.; Report of Committee on Organization of a Tree Protective Association in Connecticut.

March 1, 1923

10.00 A.M. Opening Remarks, by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; The Tree in the Landscape (Illustrated), by Ernest F. Coe, Landscape Architect, New Haven, Conn.; The Gipsy Moth, by A. F. Burgess, In Charge of Moth Work, U. S. Bureau of Entomology, Melrose Highlands, Mass.; Some Insects Attacking Shade Trees (Illustrated), by Dr. E. P. Felt, State Entomologist, Albany, N. Y. 12.15 P.M. Recess for luncheon. 2.00 P.M. The Living Tree (Illustrated), by Dr. G. E. Nichols, Assistant Professor of Botany, Yale University, New Haven, Conn.; Wood Rot Fungi (Illustrated), by Dr. W. A. Murrill, New York Botanical Garden, New York, N.Y.; Mechanical Injuries and Their Treatment (Illustrated), by Dr. G. E. Stone, Amherst, Mass.; Fertilizers for Trees, by Dr. E. H. Jenkins, Director, Connecticut Agricultural Experiment Station, New Haven, Conn.

March 11, 1924

10.00 A.M. Opening Remarks, by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Word of Welcome, by W. L. Slate, Jr., Director, Connecticut Agricultural Experiment Station, New Haven, Conn.; The

Living Tree (Illustrated), by Dr. G. E. Nichols, Assistant Professor of Botany, Yale University, New Haven, Conn.; Some Fungous Diseases of Trees (Illustrated), by Dr. A. H. Graves, Curator of Public Instruction, Brooklyn Botanic Garden, Brooklyn, N.Y. 12.15 P.M. Recess for Luncheon. 2.00 P.M. Some Insects Attacking Shade Trees (Illustrated), by Prof. W. C. O'Kane, Professor of Economic Entomology, University of New Hampshire, Durham, N. H.; Some Insects Requiring Special Attention the Coming Season (Illustrated), by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Cavity Work, Pruning, and Spraying (Illustrated), by George A. Cromie, Superintendent of Trees, New Haven, Conn.

Financial Statements

TREASURER'S ACCOUNT

July 1, 1921—June 30, 1922		
Balance on hand July 1, 1921		$213.98
Received for 18 examination fees @ $5.00	$90.00	
" " 44 renewal fees @ $2.00	88.00	178.00
		$391.98
Expended for Printing and Stationery	$28.45	
" " Postage	18.36	
" " Travel Expenses of Board	20.92	
" " Institute Expenses	36.87	
" " Miscel. office expense	1.80	106.50
		$285.48
Receipts paid Comptroller, for deposit in State Treasury		178.00
Balance on hand June 30, 1922		$107.48
July 1, 1922—June 30, 1923		
Received for 10 examination fees @ $5.00	$50.00	
" " 52 renewal fees @ $2.00	104.00	154.00
		$261.48
Expended for Printing and Stationery	$42.65	
" " Postage	6.00	
" " Institute Expenses	49.29	97.94
		$163.54
Receipts paid Comptroller, for deposit in State Treasury		154.00
Balance on hand June 30, 1924		$9.54
July 1, 1923—June 30, 1924		
Received for 21 examination fees @ $5.00	$105.00	
" " 60 renewal fees @ $2.00	120.00	225.00
		$234.54
Expended for Printing and Stationery	$3.13	
" " Institute Expenses	6.41	9.54
		$225.00
Receipts paid Comptroller, for deposit in State Treasury		225.00

COMPTROLLER'S ACCOUNT

Amounts deposited in State Treasury,		
July 1, 1921—June 30, 1922	$178.00	
July 1, 1922—June 30, 1923	154.00	
July 1, 1923—June 30, 1924	225.00	
		$557.00
Expenditures by Comptroller, on order of the Board,		
For Printing and Stationery	$64.18	
Postage	16.00	
Travel Expenses of Board	7.75	
Institute Expenses	43.52	
Miscellaneous Office Expense	11.98	
		143.43
Balance available in State Treasury, June 30, 1924		$413.57

TREE SURGERY

W. O. FILLEY

The problems confronting those interested in the protection and care of ornamental trees are many and various. Some problems relating to foliage, bark, and exposed portions of the trees are simple of solution and results of treatment are readily observed. In some cases, as in spraying with chemicals, complications may arise which require further study, but even in such cases the parts concerned are open to observation and the methods used are susceptible of proof by observation and test.

The filling of cavities, treatment of wounds, stimulation of growth by fertilization and cultivation of soils, and other problems which involve growth and condition of woody tissues are much more difficult of solution. In such cases, results from applied methods are not easy to determine, and there is great divergence of opinion regarding the efficiency of methods which are difficult to standardize. This fact makes it possible, and almost inevitable, that secret or patented processes should become the basis of business getting rather than knowledge and skill.

With due appreciation of this situation and believing that the solution of many of these problems is possible through concerted action on the part of those interested, this Board invited a number of scientists, tree workers and officials to join it in a Shade Tree Conference at Stamford, Conn., August 25-26, 1924. This conference (probably the first of its kind in this country) was attended by 36 individuals, including botanists, entomologists and practical tree workers. The definite results were summed up in the conclusions of Dr. Haven Metcalf, Forest Pathologist, U. S. Bureau of Plant Industry.

"Tree surgery," he stated, "is about where dentistry was in the 60's; its first object being looks. We believe that it does prolong the life of trees but we cannot prove it, and there is almost no literature on the subject. What is needed more than anything else is research records and case histories."

It was voted that another conference should be held in 1925, of which Dr. Haven Metcalf was elected chairman and W. O. Filley, secretary, with instructions to make all necessary arrangements.

It may be truly stated that nothing new came out of this conference. Everything which was said had doubtless been said before. Nevertheless, the meeting served its purpose in bringing together scientists and tree workers for an informal discussion of shade tree problems. Future conferences will undoubtedly show more definite progress toward their solution.

The feeling of many regarding the uncertain status of cavity work was expressed in a short paper by Dr. Collins of the U. S.

Bureau of Plant Industry. He has consented to its publication as a part of this report.

In common with many other observers, this Board has felt that the importance of cavity treatment and filling was somewhat over-emphasized, as compared with improvement of soil conditions, proper pruning and treatment of wounds, protection from insect and fungous pests, etc. Much wonderfully fine workmanship has gone into the filling of cavities, and in many cases it may have lengthened the life of the trees concerned, but in others it has only served to increase the size of the bill.

Neverthless cavity work, like the treatment of wounds, bracing, and other forms of tree repair, is demanded by tree owners, who are ready to pay for expert knowledge and skill. In return, they have a right to expect definite results, which can only be assured through standardized methods applied with judgment and honest intent. Tree workers ought to be able to say that a certain method is the right one because it has stood the test of time and is so universally used that it has become standardized. This can only come about through careful observation of results, frequent exchange of ideas with other tree workers and close co-operation with scientific workers who are keenly interested in the solution of these problems.

CAVITY WORK

J. FRANKLIN COLLINS

(Read before the Shade Tree Conference, Stamford, Conn., Aug. 25, 1924)

Before speaking of cavity work I wish to correct an erroneous impression that seems to be somewhat prevalent regarding the scope of the tree repair work being done by our Washington office. The Bureau of Plant Industry is not primarily concerned with the work of commercial "tree surgeons," nor has it ever been, so far as I know. Its primary interest lies in trying to help the man who owns a few trees (either shade, ornamental or orchard) to keep them in good condition so far as disease and mechanical injury is concerned, or to advise him how best to repair fresh injuries, as well as neglected ones that may have occurred in the past. To put the matter in another way, we are concerned primarily with the question, "What is the best advice to give to a man who has a few trees that he wants to care for himself and who would never, for financial or other reasons, employ a commercial tree surgeon to attend to them?" That is the information that we have tried to give in Farmers' Bulletin 1178, and the first paragraph in this Bulletin expressly states this to be its object. I might also add, this is its sole object.

I think it is the general opinion of the majority of tree workers that preventing decay is far better, from all points of view, than

trying to cure it. I think nearly all tree workers (certainly all scientific workers) also will agree that a decayed spot in a trunk or a large limb should be carefully cleaned out, sterilized, and treated in such a manner as to prevent, so far as possible, any reinfection.

Beyond this point there obviously is a difference of opinion even among commercial tree surgeons, as to what is the best thing to do with the cleaned out cavity: i.e., whether to leave it open, to cover it with sheet metal, or to fill it with concrete or asphalt mixtures, wood, or other materials.

For the past 15 years when traveling about the country, primarily on other business, I have made it a point to look over cement-filled cavities wherever I have been and had the time to do so, and check up on their general condition. My method of checking was to count only fillings that had been in place for a few years so as to get some idea of their permanency. Those which showed obvious cracks, chipped cement, severe dying back of the cambium, excessive leakage, or a loose filling were considered defective. Judged on this basis more than 90 per cent. of all the fillings examined have proved to be defective. I was not particularly concerned with who did the work, although in some cases I was told who did it. Undoubtedly most of this work had been done by men trained, at least to some extent, in the work, as the trees examined were located primarily along streets or on large estates where commercial men had been employed to do it.

I have had opportunity to dig out quite a number of fillings that had been in place for periods varying from eight to 15 years, and most of these, even when absolutely perfect on the surface, were found to be badly decayed back of the cement, in some cases the decayed area back of the cement was larger than the original cement-filled cavity itself. As a result of such observations as these it is hardly to be expected that the use of cement in other than small and globular cavities could conscientiously be recommended for the use of untrained persons, to say the least.

So far as asphalt mixtures or wood strips and blocks are concerned I can only say that although they appear to me to give promise of good results after they have been in practical use long enough to know just how they can best be handled, they have not yet stood the test sufficiently long to demonstrate satisfactorily to me their real value and limitations. Consequently, they are not at present recommended by us for the use of untrained men, except on an experimental basis.

SOME OF THE PRINCIPAL INSECTS ATTACKING SHADE TREES IN CONNECTICUT

W. E. BRITTON

It is often necessary to spray shade trees in Connecticut in order to control certain insects which otherwise might seriously injure the trees. In summer there are various chewing insects which devour the foliage, and there are also other insects, such as aphids and scales, which, when abundant, make a heavy drain upon the trees by sucking out the sap. Though most of these pests do not kill the trees in a single season, yet they weaken them, and if a tree is completely defoliated two or three times in succession, death may result.

In cities and towns as well as on large estates and other private holdings where the trees are an important asset, every effort should be put forth to keep the trees in the best possible health and vigor. Such a program must include provision for spraying the trees to rid them of their insect pests. Perhaps it may not be necessary to treat them every season because these pests fluctuate in abundance from year to year, and when absent, it might be wasting money to spray the trees. But the trees should be watched, and materials and apparatus should be always at hand in readiness to make the application whenever the conditions seem to warrant it. In no other way can the trees be given the most intelligent care.

What Insects Are

Insects are small animals belonging to the class Hexapoda (six-legged), and for the most part they have six legs in some stage of their existence. Those attacking trees may be divided roughly into two groups: (1) chewing insects, and (2) sucking insects. The chewing insects (except termites or white ants) have four distinct stages in their life cycles as follows: (1) egg, (2) caterpillar, grub or larva, (3) pupa, (4) adult insect. Such insects are said to have complete transformations. The sucking insects have incomplete transformations and do not pass through these four well-marked stages. There is usually, though not always, an egg stage, and an adult stage, but there is no distinct pupa, except in case of the males in certain scale insects and white flies, and the larvae are called nymphs after hatching from the eggs, and undergo a gradual development, molting several times with only slight changes until the adult stage is reached.

Chewing insects have strong jaws or mandibles with which they bite or tear off bits of the food which they swallow. Sucking insects have beaks or probosces which they insert into the tissues and suck out the sap.

Common Insecticides

Remedies for chewing insects include the arsenical poisons, but these are not effective against sucking insects where it is necessary to employ some substance which will kill by contact. Both kinds of insects may be killed by fumigation.

The most common arsenical poison used in tree spraying is lead arsenate, which may now be obtained in the form of paste, and also as a dry powder. It is used in various proportions from three pounds of paste or one and one-half pounds of dry powder in orchards, to 10 pounds of paste or five pounds of dry powder to 50 gallons of water for gipsy moth and certain other shade tree insects. A spreader is sometimes employed.

FORMULA FOR LEAD ARSENATE

Lead arsenate (paste)	3-10 lbs. or (dry) 1½-5 lbs.
Calcium caseinate spreader	1 lb.
Water	50 gals.

Paris green and calcium arsenate are often used in spraying especially on potatoes. Calcium arsenate is used extensively on cotton in the South, but it causes injury on apple foliage in Connecticut, and is not recommended for tree work. In case it seems necessary to use these poisons, ½ lb. of Paris green, 1½ lbs. air-slaked or hydrated lime may be used to 50 gallons; with calcium arsenate, 1½ lbs. each of the poison and lime may be used to 50 gallons of water.

FORMULA FOR NICOTINE SOLUTION

Nicotine sulphate may be obtained in 40 per cent. solution, and several different brands are on the market. Used to kill aphids and other sucking insects.

Nicotine sulphate	½ pint
Laundry soap	2 lbs. or
Calcium caseinate	1 lb.
Water	50 gals.

Nicotine sulphate solution may be added to lead arsenate if desired, but the soap should be omitted.

LIME-SULPHUR WASH

Liquid lime-sulphur	1 gal.
Water	9 gals.

This is used as a dormant spray to kill scale insects, and is also a good fungicide. Dry lime-sulphur preparations are now on the market and in using them, directions on the package should be followed. Diluted mixtures of lime-sulphur are also used on the foliage as a fungicide.

MISCIBLE OILS

There are several miscible oils on the market, and these may be used at the rate of one part in 15 parts of water as a dormant spray to kill scale insects, and 1-20 for spruce gall aphid.

Leaf-Chewing Insects

Elm Leaf Beetle: The elm leaf beetle, *Galerucella xanthomelaena* Schrank, hibernates in attics, belfries and other protected places, emerges from its hiding place in early spring and eats holes in the expanding leaves in May. The sexes mate and the females deposit on the under sides of the leaves, clusters of flask-shaped, yellow eggs, which, in a normal season, hatch about June 1. The larvae or grubs feed upon the green tissue on the under surface, skeletonizing the leaves. When numerous they leave only the veins and the upper epidermis, and such injured leaves turn brown and fall, usually the latter half of July. At this time the larvae reach their maturity, drop to the ground or crawl down the trunk, and on the ground around the base of the tree transform to bright yellow pupae. About 10 days later the beetles appear and go to the trees, some laying eggs for a second generation, which seldom or never does any harm in Connecticut. The late emerging beetles probably do not lay eggs, but fly about and feed more or less and go early into their winter quarters.

This insect, like humans, congregates in cities and towns, and seldom injures trees in the open country. It is even more injurious to European elms than to the American elm. It was troublesome in 1923 and defoliated trees in some localities. There was little rainfall during the pupating period, and most of the larvae came through to the adult stage. When pupation takes place during a wet period, the pupae are often attacked and killed by a white mold or fungus. *Sporotrichum globuliferum* Speg. (*entomophilum* Peck.) This fungus and the moisture were absent at the time of pupation in both 1923 and 1924; consequently the elm leaf beetle bids fair to be abundant and to cause injury to the trees in 1925. In 1924, the season was late and the insect went through its different stages and defoliated the trees much later than normal.

The remedies are to kill the beetles in attics and belfries, and to kill the pupae on the ground around the trunks of the trees by spraying them with nicotine solution and soap, and to spray the foliage, particularly the under surface, about June 1, with lead arsenate, two to three pounds of the dry powder in 50 gallons of water.

Further information regarding this insect may be obtained from Bulletin 155 of this Station.

Tent Caterpillar: The tent caterpillar, *Malacosoma americana* Fabr., usually confines its attacks to wild cherry and apple, but it is very abundant every 10 or 12 years when it may also attack oak and other trees. The eggs are deposited in July in cylindrical masses around the small twigs, and covered with a gray, glue-like substance, probably for protection. These eggs hatch when the leaf buds first open in April, and the young caterpillars from each egg-cluster live and feed together and form a web or tent in the crotch of the tree or in a fork of one of its branches. The caterpillars go outside of the nest twice a day to feed, and enter it after feeding, except when nearly full-grown they cluster on the outside of the nest. The caterpillars become full-grown about the first week in June and make their light yellow cocoons under rubbish, fence rails, etc., near the ground. The reddish-brown moths emerge two weeks later. There is only one brood each year.

The remedies are cutting off and burning the egg-clusters in winter, removing the nests and caterpillars with a caterpillar brush, or burning them off with a torch, and spraying the foliage with lead arsenate.

Additional information on the tent caterpillar may be found in Bulletin 177 of this Station.

Cankerworms: The fall cankerworm, *Alsophila pometaria* Harris, is a common pest of fruit, shade and woodland trees in Connecticut, and in some cases is accompanied by the spring cankerworm, *Paleacrita vernata* Peck, which is usually much less abundant. Both species cause the same kind of injury, and require similar remedies. Both have winged males and wingless females which crawl up the trees to lay eggs. The moths of the fall cankerworms emerge during the warm days of November and December and the females lay eggs. The adults of the spring cankerworm emerge and lay their eggs in March. The eggs of both species hatch with the first opening buds and the larvae feed upon the leaves of fruit, shade and woodland trees. Cankerworms were so abundant in Greenwich and Stamford in 1924 that small woodland areas and many shade trees were entirely defoliated. The caterpillars normally feed during May, becoming full-grown about June 1st, and during the first week in June go into the ground and transform to naked brown pupae, remaining in this stage until the following November and December, or in case of the spring species, until the following March. In the fall of 1923 the male moths were very abundant flying about and clustering on tree trunks, especially on the warm, foggy days of November and December.

There are two preventive methods: Spraying the foliage with lead arsenate during May, and employing sticky bands to prevent the insects ascending the trees. The spraying should be

done just as early as is possible after the leaves have unfolded enough to catch and hold the poison. By using a strip of cotton batting to fill the crevices in the bark covering this with a 5-inch strip of single ply tarred paper tacked at the lap, tree tanglefoot can be applied to the paper band. It should be kept sticky during November and December, and again during March and April when the eggs hatch. The whole may be removed without disfiguring the trees.

Further information may be obtained from Bulletin No. 1238, United States Department of Agriculture.

Tussock Moths: The white-marked tussock moth, *Hemerocampa leucostigma* S. and A., often injures and defoliates elm, maple, linden, poplar, horse chestnut and other trees in cities and towns. The caterpillars are bright colored and conspicuous, being striped lengthwise with yellow and brown, and having a red head and three long black tufts or pencils of hairs, two near the head and one at the tail. There are four white tufts on the front half of the body. There are two generations each year in Connecticut, one at Albany, N. Y., and three in Washington, D. C. The insect winters in the form of egg-clusters, usually on or near the old cocoons on the trees and covered with a frothy white substance about half an inch in diameter. The eggs hatch in May and the caterpillars become full-grown about the first of July, and make their cocoons on the bark of the trees. Two week later the moths emerge. The eggs for the second brood are laid in July and the caterpillars feed through August and September, then pupate, and the females lay eggs that carry over the winter.

The females, like the cankerworms, are without wings, but as they pupate on the trees, banding is not so helpful. The males are mouse color with characteristic, rather indistinct markings, and are attracted by lights.

Spraying the foliage and gathering and destroying the egg-clusters are the common methods of control.

For further information, see Report of this Station for 1916, page 105.

The hickory tussock moth, *Halisidota caryae* Harris, and the tessellated tussock moth, *H. tessellaris* S. and A. both have tufted caterpillars which feed upon apple, oak, hickory, willow, poplar and other trees, and occasionally may require a spray of lead arsenate to prevent damage. Each species is single-brooded.

For further information, see Report of this Station for 1917, page 325.

Gipsy Moth and Brown-tail Moth: The caterpillars of the gipsy moth, *Porthetria dispar* Linn., when abundant feed upon the foliage of apple, oak, birch, maple, willow, poplar, and even conifers. There is one generation each season; the eggs are laid in clusters on the bark or in cavities in trees, during July and

August, and hatch the following May. Caterpillars become mature the last of June and make their cocoons in protected places. The adults emerge two weeks later. Soaking the egg-clusters with creosote, and spraying the foliage with lead arsenate with four to five pounds of dry lead arsenate in 50 gallons of water, are the most approved methods of artificial control. So far, this insect has been kept in check in Connecticut by the forces employed by the state.

Further information regarding this insect may be found in Bulletin 186 of this Station.

The brown-tail moth, *Euproctis chrysorrhoea* Linn., formerly occurred over the eastern half of Connecticut, but has since disappeared and for several years has not been seen. It was evidently controlled by natural enemies, and it may come back again. The caterpillars feed upon pear, apple, plum, cherry, oak, elm and maple, and live through the winter in a partially grown state in small webs on terminal branches. Brown egg-masses are laid on the under side of leaves in July by the white moths with brown tufts at the end of their bodies. The caterpillars when touched by human hands cause a rash; they become mature in June and make their cocoons on the leaves.

The remedies are to clip off and burn the winter nests, and to spray the foliage in May with lead arsenate.

More detailed information may be found in Bulletin 182 of this Station.

Fall Webworm: The fall webworm, *Hyphantria cunea* Drury, is found on all kinds of fruit, shade and woodland trees the last half of summer, the caterpillars feeding upon leaves enclosed in nests near the ends of the branches. There is a partial second brood in Connecticut, and the eggs are laid on the under side of leaves by the white female.

Clipping off and burning these nests, and spraying the trees with lead arsenate are the remedies.

For further information, see Report of this Station for 1917, page 319.

Walnut Caterpillar: Hickory, butternut and black walnut trees are often stripped of their leaves in late summer by the walnut caterpillar, *Datana integerrima* G. & R. This is a black caterpillar covered with whitish hairs, which feeds gregariously. They molt and leave the cast skins, in the form of gray patches on the tree trunks. Spraying with lead arsenate is the remedy.

For further information, see Report of this Station for 1917, page 326.

Sawflies on Conifers: There are several species of sawflies, the larvae of which feed on the various species of pine trees, occasionally defoliating them. One of the most destructive is the imported pine sawfly, *Diprion simile* Hartig, which attacks the

white pine and other five-needled pines; these may also be attacked by *Neodiprion pinetum* Norton, *Neodiprion lecontei* Norton, and other species feed upon the pitch pine and other kinds of pines.

The larch sawfly, *Lygaeonematus erichsoni* Hartig, is occasionally so abundant as to defoliate larch trees, and sometimes spruce trees are injured by *Neodiprion abietis* Harris. The proper remedy against all these pests is spraying with lead arsenate.

For further information regarding the imported pine sawfly, see Report of this Station for 1917, page 273.

Larch Leaf-miner or Case Bearer: This insect, *Coleophora laricella* Hubn., is a small moth and the larva tunnels inside the leaves from June to September, often ruining them. It then migrates to the twigs, where in brown, cigar-shaped cases it passes the winter. A dormant spray with liquid lime-sulphur in early spring will kill the larvae in their winter cases and is the best remedy known.

Further information may be found in the above mentioned Report, page 288.

Arbor-vitae Leaf-Miner: This small moth, *Argyresthia thuiella* Packard, has recently caused serious injury to arbor-vitae trees and hedges in Connecticut. The tiny larvae tunnel inside the leaves, causing them to appear transparent and later turn yellow and brown. The adults emerge late in May and early in June, and spraying with nicotine solution and soap when the adults are flying and laying eggs will materially reduce the pest.

For further information, see Report of this Station for 1921, page 157.

Imported Willow Leaf Beetle: This small, shiny blue beetle, *Plagiodera versicolora* Laich., has been brought into this country and has spread from the vicinity of New York to various parts of Connecticut. It prefers shiny leaved willows, but may attack poplars. Eggs are laid on the leaves and both beetles and grubs feed upon the leaves, skeletonizing them. There are two complete broods each season, and the beetles hibernate. The remedy consists of spraying with lead arsenate.

For further information, see Report of this Station for 1921, page 195.

Birch Leaf Skeletonizer: The larvae of a small moth, *Bucculatrix canadensisella* Chambers, often skeletonize the leaves of gray, white and yellow birch trees late in the season. There is only one annual generation, and the insect passes the winter in cocoons on the fallen leaves. The remedy consists of spraying with lead arsenate during August.

For further information, see Report of this Station for 1910, page 701.

Spiny Elm Caterpillar: Black, spiny caterpillars are often found feeding gregariously on elm, poplar and willow, stripping the branches. This insect is called the spiny elm caterpillar, and is the larva of the mourning cloak or Antiopa butterfly, *Euvanessa antiopa* Linn. There are two broods each year in Connecticut, and the adult butterflies live through the winter and may be seen flying on warm days. As the caterpillars feed in colonies it is often possible to crush them on the tree or after cutting off the infested branches. Spraying the foliage with lead arsenate is a remedy.

For further information, see Report of this Station for **1906**, page **260**.

Borers or Wood-Chewing Insects

Maple Borer: Sugar maple trees are commonly injured by the maple borer, *Glycobius speciosus* Say, a handsome black beetle with yellow markings, and about an inch in length. A conspicuous mark is the W on the base of the wing-covers. The beetles appear in Connecticut the first half of July, and a little later the eggs are laid. The tiny grub begins tunneling in the bark, soon entering the sapwood, where it works around the trunk or branch, usually going upward in a spiral course. Two years are probably required for the complete life cycle, and, of course, the grub increases in size with age and makes a much larger burrow when it is nearly full-grown. This results in some large scars on the trees, and when two or more grubs are at work in the same trunk, they sometimes girdle it and the tree breaks over. When mature, the grub pupates in the burrow and emerges the following July through a nearly circular, somewhat flattened hole, nearly half an inch in diameter. The best control measure is to examine trunk and branches of choice maple trees, preferably in September, find the grubs by following up the sawdust emitted, and cut them out or kill by inserting a wire in the burrow. Also destroy the adult beetles when found resting on the trunks of trees in July.

For further information, see Report of this Station for **1922**, page **351**.

Leopard Moth: Elm, maple and other shade trees as well as fruit trees are attacked by the leopard moth, *Zeuzera pyrina* Linn. The female moth has a wing-spread of about two and a half inches, is white with fore-wings coarsely dotted with blue and black spots. The male is smaller though similarly marked. The moths emerge mostly in July. Eggs are laid in crevices in the bark, and the young caterpillars usually enter the twigs at the base of a bud, and after feeding for a time, leave their burrows and enter larger branches where they excavate large, irregular galleries. The branches are weakened and often break off. The

grub is white or pinkish, with head, neck shield and tubercular spots, black; it is nearly three inches long when fully grown. The borer causes most of its damage the second summer, lives in the burrow the following winter and pupates, the moths emerging in July, two years being necessary for its complete life cycle. A systematic cutting and burning of infested branches will check the pest, and where sawdust is thrown out from the main trunk and larger branches it is possible to dig out the borers. A wire may be inserted in the burrow or a few drops of carbon disulphide injected and the opening closed to kill the borers.

For further information, see Report of this Station for 1911, page 317.

Bronze Birch Borer: Many European white birches, particularly the cut-leaf form, have been killed during the past few years by the bronze birch borer, *Agrilus anxius* Gory. This small beetle begins its attack on the branches in the upper part of the tree and spiral swellings or ridges show on the surface of the bark. Later the lower branches are similarly affected and the tree is soon killed. Native species, though not immune, are less susceptible to injury. If a tree becomes generally infested, it cannot be saved. The beetles emerge in June, feed for a time on the leaves and lay eggs in slits in the bark. There is only one brood annually and the grubs make shallow galleries in the sapwood just beneath the bark. Where a few branches are infested, they should be cut off and burned in early spring. Dead trees should also be burned before the beetles emerge. As the beetles feed somewhat on the leaves, the trees should be well coated with lead arsenate early in June.

For further information, see Report of this Station for 1922, page 359.

The Twig Pruner: Small terminal twigs of oak and some other trees are often cut off by a borer in late summer and fall upon the ground. This is the work of the twig pruner, *Hypermallus villosum* Fabr., one of the long-horned beetles. There is only one brood each year and the borer usually drops to the ground in the base of the severed twig. Consequently, gathering and burning these twigs is advisable, and about the only control measure known. Trees are not seriously injured by the attacks of this insect.

For further information, see Bulletin 332, Ohio Agr. Expt. Station, page 327.

Carpenter Worm: Large grubs, occasionally found tunneling in the heart wood of ash, elm, and other trees, are called carpenter worms, and are the larvae of one of the Cossid or goat moths, *Prionoxystus robiniae* Peck. It is related to the leopard moth, and there is one generation each year. About the only remedy

is to inject carbon disulphide into the burrows and close the opening, or cut out the grubs.

For further information, see Bulletin 332, Ohio Agr. Expt. Station, page 329.

Locust Borer and Painted Hickory Borer: Young locust trees are often killed or deformed by the locust borer, *Cyllene robiniae* Forst., and hickory trees are less seriously injured by a closely related species called the painted hickory borer, *Cyllene pictus* Drury. In fact, some claim that these two species are identical, but there are slight structural differences and the adult of the painted hickory borer emerges in the spring, while the locust species appears in the fall. Both are long-horned, black beetles, three-fourths of an inch in length, marked with narrow cross-bands of greenish yellow and with a W-shaped mark on the base of the wing covers. The life cycle of each occupies about a year. Dr. Craighead reports success by injecting into the burrows kerosene soap emulsion made with water containing five per cent. of sodium arsenate.

For further information, locust borer, see Bulletin 787, U. S. Department of Agriculture: Painted hickory borer, New York State Museum Memoir 8, page 264.

Saperda Borers: Linden trees are often injured by the linden borer, *Saperda vestita* Say, hickory by the hickory borer, *Saperda discoidea* Fabr., poplars by the poplar borer, *Saperda calcarata* Say, elms by the elm borer, *Saperda tridentata* Oliv., and apple by the round-headed apple borer, *Saperda candida* Fabr. Trees badly infested with the elm borer should be cut and burned. These borers are usually cut out, but carbon disulphide may be employed and possibly the poisoned kerosene emulsion may prove successful.

For further information regarding these borers, see Manual of Tree and Shrub Insects.

White Pine Weevil: The leaders or top-most shoots of young white pine trees are commonly attacked and killed by a snout beetle, *Pissodes strobi* Peck, which lays eggs in punctures in the bark of the leader during May. Numerous grubs hatching from these eggs tunnel in the stem, becoming full-grown about July 1, and pupate in oval cells in the wood. The leaders wilt and die during July. Repeated attacks cause the trees to become crooked, forked and ill-shaped. It is commonly recommended that the leaders be cut off and burned before the adults emerge, or still better, place them in cages which will permit the escape of their parasites but not of the snout-beetles. Small plantations and choice ornamental trees may be protected to some extent by spraying the leaders about May 1, with liquid lime-sulphur (1-9) or lead arsenate, or by jarring the leaders twice a week for six weeks and catching the beetles in a net.

For further information, see Report of this Station for **1919**, page 144.

The Hickory Bark Beetle and Other Bark Beetles: Hickory trees are beset more or less periodically by epidemic attacks of the hickory bark beetle, *Scolytus quadrispinosus* Say, which breeds in the cambium, effectually girdling the tree. Later the exit holes give the tree the appearance of having been punctured with shot. Thousands of hickory trees have been killed in Connecticut by this insect during the past 25 years. The adults feed on the leaf petioles, and a thorough spraying of the foliage about July 1, with lead arsenate and nicotine sulphate is believed to be of some benefit. Badly infested trees should be cut and burned or barked before the beetles emerge. Related bark beetles with similar habits attack pine, spruce and other kinds, usually the unthrifty trees. Keep all trees as vigorous as possible. Cutting and burning the infested trees will generally check the outbreak.

For further information, see Manual of Tree and Shrub Insects.

The Parandra Borer and the Maple Sesian: Weakened trees of nearly all kinds are attacked by a brown beetle known as the Paranda borer, *Parandra brunnea* Fabr., which tunnels in the heartwood near the ground. The maple sesian is a clear-wing moth, *Sesia acerni* Clem., which breeds in the vicinity of wounds on the trunk and branches, particularly of soft maples. Careful dressing of the wounds is a good preventive. Where trees are kept in a thrifty condition there is little injury from either of these insects.

For further information, see Report of this Station for **1921**, page 201 (Parandra borer), and for **1922**, page **355** (maple sesian).

Pigeon Tremex: The pigeon tremex, or horn-tail, *Tremex columba* Linn., is a borer in dead and dying trees of nearly all deciduous kinds, and is common in maple, elm and hickory. Round holes the size of a lead pencil mark the points of exit of the adults, which are rather large, four-winged flies, about two inches in length, marked with yellow and black and with a conspicuous horn or ovipositor at the rear end of the body. Trees which are infested by the pigeon horn-tail are commonly visited by two of its very conspicuous parasites called "long stings." In fact, the parasites are usually the first indication to the owner that anything is wrong with his tree, and he thinks them responsible for the injury. The black long-sting, ***Megarhyssa atrata*** Fabr., and the lunate long-sting, ***Megarhyssa lunator*** Fabr., are among the largest of the parasitic Ichneumon flies, and the females have bristle-like ovipositors nearly four inches in length and resembling horse hairs.

For further information, see Manual of Tree and Shrub

Carpenter Ant and Termites: Trees are often tunneled and honeycombed by the large, black, carpenter ant, *Camponotus herculeanus pennsylvanicus* DeGeer, and by the so-called white ants or termites, *Reculitermes flavipes* Kollar. The white ants are white only in their immature stages, the adults being brown. The best remedy for both species is to inject carbon disulphide and confine it in the burrows by plugging the opening.

For further information, see Report of this Station for 1922, page 365.

Sucking Insects

Spruce Gall Aphid: Cone-shaped galls at base of new growth on Norway, black, white and red spruce trees are caused by the spruce gall aphid, *Chermes abietis* Linn. This insect has two generations each year the winter being passed by the immature females on the twigs, and particularly around the buds and under the bud scales. They reach maturity in spring, and lay their eggs about May 1. The young cluster at the tips where the new growth starts, and form the cone-shaped galls. The insects become mature in August and escape from the galls and lay eggs for the second brood. Another species *Chermes cooleyi* Gillette, makes larger galls on the Colorado blue spruce. Thoroughly spraying with nicotine solution and soap, or with a miscible oil (1-20) in the fall or spring will hold this pest in check. Clipping off and burning the galls in early summer can also be practiced on small trees.

For further information see Report of this Station for 1922, page 357.

Leaf Aphids: There are many kinds of aphids which injure the various kinds of trees by sucking sap from the leaves. Some of these are: Green apple aphid, *Aphis pomi* DeG., rosy apple aphid, *Anuraphis roseus* Baker, of apple; woolly aphid of apple and elm, *Eriosoma lanigera* Hausm.; woolly beech aphid, *Prociphilus imbricator* Fitch; birch aphid *Calaphis betulaecolens* Fitch; pine bark aphid, *Chermes pinicorticis* Fitch, and many other species. As a rule, these aphids may be held in check by spraying with nicotine solution and soap. Calcium caseinate may be used as a spreader in place of soap. Dusts containing nicotine may also be blown upon the leaves.

Further information may be obtained from Manual of Tree and Shrub Insects.

Hickory Gall Aphid: The compound leaves of hickory are often distorted and fall in midsummer on account of the attacks of the hickory gall aphid, *Phylloxera caryaecaulis* Fitch, which forms hollow, globular galls on the leaf petioles, often causing them to break off. Apparently no control measures have been worked out for this insect.

For further information, see Manual of Tree and Shrub Insects.

Oyster-Shell Scale: The oyster-shell scale, *Lepidosaphes ulmi* Linn., kills branches and sometimes entire trees, and attacks many kinds of deciduous trees and shrubs. Some of those most commonly attacked are ash, maple, apple, poplar, willow, butternut, birch and lilac. Silver maple street trees are sometimes seriously infested and it makes the branches very brittle so that they break off in storms. This insect has one generation each year and passes the winter as white oval eggs under the old female shells. These eggs hatch during the last days of May, and the young crawl about for several hours and establish themselves on the bark, begin to suck the sap and remain stationary afterward. Late in August, the females become grown and die after depositing eggs under the shells. The shells are mussel-shaped, about an eighth of an inch long, and gray or brown, usually nearly the color of the bark. Spraying with lime-sulphur (1-9) or miscible oil (1-15) in early spring has proved effective. Also a spray of nicotine solution and soap or with kerosene emulsion about June 10th will kill the newly-hatched young.

For further information see Report of this Station for 1903, page 229.

San José Scale: This is a small, circular scale, grayish in color and about one-sixteenth of an inch in diameter. The shell is formed of concentric rings with a nipple in the center. It is called the pernicious or San José scale, *Aspidiotus perniciosus* Comst., and it attacks many different kinds of trees and shrubs, but shows a preference for fruit trees and shrubs of the rose family. There are three broods each year, and the winter is passed in a partially grown condition. The young of the first brood appear the last days of June. Though in part controlled by natural enemies, this insect formerly destroyed hundreds of fruit orchards, and after subsiding as a pest for several years, is now troublesome again. A dormant spray of lime-sulphur (1-9) or of miscible oil (1-15) are the remedies.

For further information, see Bulletin 165 of this Station.

Maple Woolly Leaf Scale: Sugar maple trees throughout the cities and towns of Connecticut are attacked and injured by the woolly maple leaf scale, *Phenacoccus acericola* King. The females are found on the under sides of the leaves in midsummer where they produce their eggs in large flocculent masses of white wax, resembling tufts of cotton or wool. Badly infested leaves drop in July. The male cocoons as well as the winter cases of the immature females are placed in the crevices of the bark of the trunk and at the base of the larger branches. There are three broods each season. Spraying the winter cocoons on the dormant trees in March using lime-sulphur (1-9) with the addition of nicotine has proved an effective remedy in New Haven.

For further information see Report of this Station for **1905**, page **226**.

Cottony Maple Scale: Soft maples in the vicinity of Stamford for several years have been badly infested with the cottony maple scale, *Pulvinaria vitis* Linn., which also attacks many other kinds of trees. This insect has one generation each year and passes the winter in the form of thin, brown, oval, soft scales on the bark of the twigs. In early summer the development of the egg-sac causes one end of the brown scale to be lifted by a cotton-like mass of white wax. The young are crawling in July. Spraying the trees with miscible oil (1-15) in spring before the buds start has given good control.

For further information, see Report of this Station for **1921**, page 179.

Terrapin Scale: Another pest of soft maples is the terrapin scale, *Lecanium nigrofasciatum* Pergande, a small, reddish, convex species occurring on the smooth bark of the smaller twigs. Occasionally the sugar and Norway maples and other kinds of trees are attacked by this scale. Badly injured branches should be cut off and burned, and the trees sprayed in early spring with miscible oil (1-15) or with a kerosene emulsion containing **20-25** per cent. of kerosene.

For further information, see Report of this Station for **1921**, page 183.

Tulip Tree Scale: The lower branches of tulip trees are often infested and killed by the tulip tree scale, *Toumeyella liriodendri* Gmel., which appears as brown hemispherical shells nearly one-third of an inch in diameter. There is only one brood each year, and the young hatch in September, establish themselves on the bark, and pass the winter in a partially grown state. The next season they continue to suck sap from the branches, becoming mature in August, and the honey dew drips upon the ground and lower leaves, appearing like a coat of varnish. The best times for treatment are after the leaves drop in the fall, or just before they put out in the spring. Liquid lime-sulphur (1-9) or a miscible oil which does not contain phenol, may be used for this purpose.

For further information, see Report of this Station for 1921, page 176.

Elm Scale: The trunks of small elms and the lower branches of larger trees are often infested and injured by a soft scale called the elm scale, *Gossyparia spuria* Mod. This scale occurs in longitudinal rows in the crevices of the bark, and is oval in shape, chocolate brown in color margined by a whitish fringe of wax filaments. There is only one brood each year, winter being passed in a partly grown state, and the young appear late in June. Spraying with miscible oil in early spring is a satisfactory remedy.

For further information, see Manual of Tree and Shrub Insects, page 161.

Pine Leaf Scale: Small pine trees in protected places are often infested with the pine leaf scale, *Chionaspis pinifoliae* Fitch, which appears as white elongated shells on the needles. It attacks the various species of pines but seldom causes injury in exposed situations. There are two generations each year, though not well defined, the young of the first brood beginning to appear in May and the second in July. It passes the winter in the form of purple eggs under the shells. Badly injured branches should be cut off and burned. Dr Felt advises spraying with miscible oil (1-16) in spring, but it is probable that summer applications of nicotine solution and soap will also keep the pest in check.

For further information, see Report of this Station for 1921, page 181.

Other Scale Insects: There are several other kinds of scales which are occasionally troublesome, such as the scurfy scale, *Chionaspis furfura* Fitch, on trees and shrubs of the rose family, the rose scale, *Aulacaspis rosae* Bouché on roses and blackberries, the euonymus scale, *Chionaspis euonymi* Comst., on euonymus, the apricot or European fruit scale, *Eulecanium corni* Bouché, on various trees and shrubs, and the golden oak or pit-making oak scale, *Asterolecanium variolosum* Ratz., on golden oak. Send specimens to the Station for identification and advice about treatment.

For further information, see Manual of Tree and Shrub Insects.

Lace Bugs and Leaf Bugs: Leaves of sycamore are commonly attacked and somewhat injured by a lace bug, *Corythucha ciliata* Say, oak by another species, *Corythucha arcuata* Say, and rhododendron by *Leptobyrsa rhododendri* Horv. Several kinds of leaf bugs of the family Miridae also injure the leaves by sucking out the sap. As a rule all of these may be controlled by spraying the under sides of the leaves with nicotine solution and soap as for aphids.

FUNGOUS AND NON-INFECTIOUS TROUBLES OF ORNAMENTAL TREES

G. P. CLINTON

This article does not include the troubles of fruit or forest trees except as grown for purely ornamental purposes. Aside from the injuries caused by insects, which are treated elsewhere in this report, the other troubles of ornamental trees fall into two classes: First, a variety of more or less obscure troubles, often non-progressive and always non-infectious, due to a great variety of causes, which we may designate as "unfavorable environment." Second, definite infectious and progressive diseases, which are caused by fungi.

NON-INFECTIOUS TROUBLES

Because the agents are so obscure or are present only for a short period, these troubles are the hardest to identify. Likewise the symptoms may be so similar from dissimilar causes, that, lacking both agent and characteristic symptoms, one often has to give a guess as to the cause. The elimination of other possible causes and extended observation, help to make the guess of value. In our experience with ornamental trees, we have found injuries of the following character: Winter, Drought, Smoke and Gas, Spray, Electrical and Mechanical.

Berls, Knots, Bunched Sprouts: Besides these determined troubles, there occur on certain trees growths whose cause is not definitely known. We do not include here the galls caused by insects, whose nature is usually revealed by some signs of larvae at their center.

Knots: On oak and less frequently on hickory, there are occasionally seen on ornamental, as well as on forest trees, hard, roundish, gall-like growths that vary in size from an inch to a foot in diameter. Usually several or many of these may occur on a single tree, while other trees of the same variety in the vicinity show no such growths. This looks as if the trouble were spreading over the tree. Its infectious nature, however, remains yet to be proved. The resemblance of the smaller knots to crown gall has caused some to think that they may be bacterial in nature. Whatever its cause, this trouble apparently starts with injury or irritation to the cambium layer, so that it is stimulated into great activity and in such unusual directions as to form a gall-like growth rather than the natural woody layers. This growth, however, is usually not so permanent as the normal tissues, though many knots are of considerable age as shown by the growth rings. Where feasible, such growths may be removed by cutting off the branch some distance below the growth.

Bunched Sprouts: Besides knots, certain trees, especially elms and maples, occasionally show bunched growths of fine branches or unexpanded buds on the main trunk. These evidently come from adventitious buds developing because of some hidden injury to the tree. The writer suspects that winter injury is often the cause. When abundant, they give the main trunk a somewhat knotted or scraggy appearance. Continued pruning will probably finally prevent their reappearance.

Winter Injuries: *Conditions.* Trees show winter injuries under the following conditions. 1. Some trees are not hardy, being grown too far north or out of their natural environment. There is a demand for trees of all sorts for ornamental purposes, and nurserymen aim to supply the demand. Inexperience at first induced them to grow semi-tropical trees that were easily winter injured, but now they have largely cut out these for their own protection. However, there are still grown a number of species that are not entirely acclimated and, of course, these suffer most. 2. A cultivated or fertilized fruit tree is more likely to suffer from winter injury than a native forest tree. This is partly because the tissues make a faster, softer growth that often does not properly mature before winter sets in. The ornamental tree occupies a position between these two classes, as it sometimes receives cultivation or fertilization or both. 3. Ornamental trees often stand by themselves and so are more exposed to wintry blasts or, on the other hand, they are planted in sheltered nooks where they receive undesirable stimulation during warm, sunny, winter days. 4. Warm winter weather followed by sudden drops in temperature or extreme cold weather may cause injury to trees ordinarily hardy.

Causes and Types. Winter injury takes place in a variety of ways. With trees grown for their blossoms, severe winter weather or late spring frosts may destroy the blossom buds. Warm, sunny weather of some duration may start sap activity on the south or southwest side and result in death of the bark there, so-called winter sun-scald, when the temperature suddenly drops.

Cankers caused by killing the bark in localized spots, especially at the base of the tree, may result, the latter type being known as collar girdle. We have seen elm trees in the vicinity of Stamford and New Haven that showed cankers of varying size, small on the branches but a foot or more on the main trunk where they are most frequent, for which investigators have been unable so far to find any definite insect or fungous cause. The most reasonable supposition, with our present knowledge, is that these are winter injuries where the cambium has been killed in localized spots. See Plate XV, c.

We have also been shown an elm tree, in Stamford, by the head of the F. A. Bartlett Company, where the inner bark had

been winter killed while the cambium remained alive, so that a new growth of smooth bark was formed beneath and finally sloughed off the outer rough bark, thus presenting an unusual appearance.

Sometimes the cold is severe enough to kill trees outright. Even when the tree has its wood properly matured, if the cold is sudden and severe, the difference in temperature between the inner and outer wood is so great that the contraction of the tissues outside is faster than within, and frost cracks suddenly appear in the bark or wood lengthwise of the tree. When healed over, these often show as ridges on the trunk.

With improperly matured wood, winter injury may be localized in the sap wood. If severe and extended enough to kill it prematurely, the next year the tree suffers from lack of sufficient carrying space for the elaborated sap, and the tree makes a very slow growth. This injury shows through the prematurely darkened color of the sap wood, when cut across, and is sometimes followed by rot fungi.

Finally, the injury may be localized in the roots, which are injured or killed, because of too much moisture in the soil in wet places or because weakened by summer droughts. Here the injury is usually hidden from view but sometimes can be detected where the exposed roots join the trunk.

Drought and Heat Injuries: *Heat,* as such, apparently causes very little injury to trees, though, as a factor in excessive transpiration from leaves where there is a limited supply of water to replace that lost, it is indirectly involved. When strong sun light beats down on the exposed south and west sides of trees recently transplanted, and summer sun-scald results, it is probably more directly a cause, though even here the loss of water is a factor. Shading the trunk by V-shaped boards on the south side lessens injury in such cases.

Leaf Scorch. Lack of moisture in the soil, injuries to the roots or wood preventing the conveyance of water to the leaves, bright sunshine suddenly following rainy or muggy weather, or unusually hot days—all are factors in causing transpiration of water from the leaves faster than supplied by the roots with resulting leaf scorch troubles. Whipping winds, also by favoring transpiration and by mechanically injuring the young leaves, are often involved in such troubles. Hard maples, more than any other ornamental trees, are subject to leaf scorch in this state, and, as this injury usually appears suddenly and conspicuously, people often suspect it as being a fungous injury. The tissues of the leaves, especially at their edges, are killed in an irregular manner turning a reddish or brownish color and later they are often infested with saprophytic fungi. They usually adhere to the tree throughout the season, although some may drop pre-

maturely. Sometimes only one tree of several together may show the trouble; this may indicate root injury. Again, trees may show it only on the more exposed side. In the early spring of 1924, when the injury was prominent, trees on the exposed hills were the ones that suffered most. In this case a whipping wind was a prominent factor in the injury. Besides the hard, other maples, elm, ash, and linden less frequently show leaf scorch. Sometimes the pine needle blight is caused in these ways.

Scorch of Evergreens. Another type of leaf scorch is that shown on a variety of evergeens in which the foliage is browned and eventually killed on the more exposed trees, particularly when young in nurseries. Frequently this takes place in late winter or early spring before growth has started, and results from warm days causing transpiration from the leaves when the ground is frozen and the tree cannot replace the water so lost. Again, in severe winters, it may be entirely due to the unusual cold which partly kills the old leaves. Less frequently a very late frost, after new leaves have started, kills their exposed ends but does not injure the protected growing bases, so that the leaves continue to grow but retain the permanently injured tips. These troubles may be considered as a purely winter or a combination of winter and drought injury.

Pine Needle Blight. This is a special form of the leaf scorch of evergreens, and is due to the same causes. The white pine is by far the most susceptible species. The needles are killed from the tip inward, sometimes for half their length. If the injury occurs early in the season, the leaves are often dwarfed and somewhat bunched. As the leaves usually adhere for at least two years, this injury continues to be conspicuous the second year and affects the growth of the tree that year as well. With injury to the new leaves the second year, the trees not infrequently die. Other trees lag along in a sickly condition for a number of years; while those little injured, and with vigorous roots, recover and show no special signs of injury after the blighted needles drop off.

Severe Summer Drought also may cause the premature death of the older leaves of evergreens. These leaves, further back on the branches beyond the new growth, turn brown and eventually drop off prematurely. Before they are shed the injury is prominent because of the evident contrast between the dead and living leaves on the same branch. This prematuring and dropping of the oldest living leaves is merely an effort on the part of the tree to preserve the moisture for the younger leaves and hence protect them from injury. It was quite conspicuous this year, especially on species of Arbor-vitae and Retinosporas, and traced back, in part, to the very dry summer of last year, as well as to the drought of this year.

Yellow Leaf and Leaf Fall. A type of drought injury to deciduous trees is that which takes place when there is a continued severe drought in midsummer or early fall. In this case the roots cannot supply sufficient moisture for the leaves, with the result that those least vigorous and having the most competition for the water drop off. Most leaves of a tree do this gradually, often turning yellow before they fall, as with the elm which also sometimes sheds its young branches as well. With the Norway maple, on the other hand, the leaves may drop off while still green. The dry summer of 1923 caused more of this trouble than that of 1924.

Injured Rootlets. Everyone knows that in transplanting a tree the roots should not be allowed to dry out too much. In case of severe drought this undoubtedly takes place in nature, with the premature death of many of the finer feeding rootlets. The direct injury though hidden from view is shown, in part, by the leaf fall to readjust the foliage and root relationships. Frequently the whole story is not told until the succeeding year, when scantier foliage results, especially as shown in 1924 by certain fruit trees. No doubt, too, such trees come through the winter with less vigorous roots and sapwood. It is difficult, therefore, in some cases where trees are backward, to determine how much injury is due to drought and how much to winter injury, as both may be involved even when the winter is not unusually severe.

Smoke and Gas Injuries: *Smoke Injury* of trees in this state usually comes from brick kilns, though occasionally we have seen injury from smoke stacks of factories. In any case, the injury results from sulphur in the coal that, on burning, escapes into the air as sulphur dioxide. Ordinarily this does no harm, when the atmospheric pressure is such that the smoke is carried upward, but when it drags along the ground and the leaves are moistened by rain or dew, this sulphur dioxide is absorbed by the moisture and apparently changed to sulphurous or sulphuric acid with accompanying burn of the foliage. Such injury has occasionally occurred to the trees in East Rock Park and near-by yards in New Haven, showing on birch, beech, elms, maples, spruce and other conifers. With the maple its injury is similar to that caused by sun scorch or gas. Such smoke injury may also affect other vegetation and law suits have occasionally resulted. The smoke in railway yards from engines seems to be more objectionable from the soot settling on the leaves than from actual burn.

Gas Leaks in mains often cause injury to street trees. The leak may not always be close to the tree, but the gas, by following the pipe escapes into the soil in the vicinity of the roots, injuring or killing them. The visible effect is shown, in time, by the sickly appearance or death of the leaves. Hard maples seem to

be most subject to this trouble, and the injury to these is very similar to that of sun scorch. This latter source of injury should be first eliminated as a cause. A gas leak can usually be detected only by the odor, and is especially evident when a hole is bored into the soil at a suspicious location. The gas is rarely or never strong enough to ignite from a match.

Spray Injuries: Occasionally in spraying trees to prevent insect or fungous troubles, there results more injury than caused by these agents. This is not always the fault of the person applying the spray, as he may be doing it under conditions recommended by scientific investigators and which ordinarily cause no injury.

Insecticides. With these, where arsenic in some form is generally used, the poison is supposed to be practically insoluble and so incapable of injury, but various brands, at times, contain an amount that is soluble beyond the danger point. Again the other ingredients, with which the insecticide is combined, may raise the solubility to this degree. For example, the use of salt water from the Sound has been known to increase the solubility of lead arsenate, and produce injury that did not previously occur with the use of well water. Also when mixed with fungicides, the combination of ingredients used sometimes increases the solubility of the arsenic. With certain of the oils or emulsions improperly mixed or applied, serious injury may result even to dormant trees.

Fungicides. On the other hand injury may be directly due to the fungicide as this must be used at a strength that kills, by contact, the fungus, but ought not to be strong enough to injure the tissues of the leaves. Sometimes this strength is beyond that of safety to the foliage, especially of certain trees, and injury results. Again, chemical change, as with Bordeaux mixture, may occur after the spray is put on the foliage; or the higher temperature or rains, following the treatment, are deciding factors that produce injury that would not ordinarily occur. Lastly, sprays are sometimes applied that are sure to cause more or less damage and should never have been used; the injury from this source, however, is becoming less frequent because of greater caution on the part of manufacturers in trying out their insecticides and fungicides before placing them on the market.

Electrical Injuries: *Electric Wires.* The injury from electrical currents, either direct or alternating, of high voltage occurs when the wire comes in direct contact with the wet branches or leaves. Street trees are the most exposed to these conditions. Personally, we have seen very little serious injury from this cause. We have, however, observed street trees along car lines where an occasional branch or leaves or small branches have been killed. Where the feed wire ran through the trees and its insulation had become worn, we have seen maples, whose wet leaves

had blown in contact with the wire at these points, with localized dead foliage on a considerable number of trees.

Stone (Mass. Agr. Exp. Sta. Bull. 170: 233.) says: "When strung too close to trees, wires also often cause serious injury by burning, sometimes mechanical injury is done, and lightning discharges will cause harm when guy wires are attached to trees. Both the alternating and direct currents are used. They produce different physiological effects on plant life, the alternating current apparently being less injurious than the direct. . . . . Most of the injury to trees from trolley or electric light currents is local, *i.e.*, the injury takes place at or near the point of contact of the wire with the tree. This injury is done in wet weather when the tree is covered with a film of water which provides favorable conditions for leakage, the current traversing the film of water on the tree to the ground. The result of the contact of a wire with a limb under these conditions is a grounding of the current and burning of the limb, due to 'arcing'. The vital layer and wood become injured at the point of contact, resulting in an ugly scar and sometimes the destruction of the limb or leader. . . . . Practically all of the burning of trees from either alternating or direct currents occurs in this way, since the high electrical resistance characteristic of trees does not permit injurious currents to pass through their tissues."

There were occasional cases, however, where Dr. Stone found that large trees had been killed when the wire in contact, contrary to the usual custom, carried the negative current and the rails the positive. This resulted in a girdling of the tree near the base and its subsequent death. Professor Toumey claims that injury to the trees may, in part, be due to copper and zinc compounds carried from the corroded wires into the tissues so injured.

Lighting Injuries are said to be of two types, the most common one is where the tree is struck directly and the injury is entirely mechanical, splitting open the wood and breaking loose the bark or breaking off large limbs. Such a tree remains otherwise entirely normal and may live indefinitely, if the mechanical injury has not been too severe or opens the way to further injury by other agents. Plate XV, d, shows a large white pine at Cornwall, Conn., that was injured in the fall of 1917 but is still living.

On the other hand trees when struck are occasionally so badly injured, apparently in the cambium layer, without much evident mechanical injury that death results immediately or in a short time. We have seen white pine trees, dead and dying, where we could find no other evident cause. Mr. Stoddard, of this department, records a case of an oak shade tree at Litchfield, that was struck, and the leaves were immediately killed, the tree soon dying without evident mechanical injury.

In a few cases we have heard of shade trees on which, after a storm, the leaves, or part of them, suddenly died while still

green. In these cases it is possible that the injury was the result of earth discharges as reported by Stone. He says: "These discharges occur during thunder storms, and those who have observed them for many years relate that they give rise to a dull, characteristic report resembling that caused by throwing a wet cloth on a hard surface. The whole tree is not affected as a rule, as the lightning stroke seldom follows up the main trunk, but discharges at the point of several branches. As a rule, however, one side of the trunk and one or more of the limbs on that side are affected and the symmetry of the tree destroyed. The first indication of the discharge is shown by the immediate wilting and subsequent death of the leaves of the affected limbs, which also die later. In the course of time cracks similar to those caused by frost, and later ridges due to healing, will be seen on the trunk, showing the path of the discharge, and occasionally, when the injury is considerable, the bark near the affected part of the tree falls off. The limbs, however, are not always killed, frequently splitting and a cracking of the wood for some depth is now and then observed on the trunk and limbs along the path of discharge."

Mechanical Injuries: Besides the special types of mechanical injuries already mentioned, these may be caused in a variety of other ways, such as by hail, ice and wind storms and by animals, of which mice, horses and men are the chief offenders.

Hail Injury on fruit trees is frequently conspicuous, but apparently shade trees suffer less because of their more hardy bark. On July 17th of the present year, one of the most severe hail storms of recent years caused great harm to the fruit trees in the vicinity of Wallingford, and less costly, though evident, injury to the shade trees. A severe wind greatly exaggerated the injury, as the large hail stones struck with great force. On one small apple tree less than 10 feet high, we counted over 450 distinct bruises on the trunk and limbs. Many of these showed the bark killed, drying up or sloughing off in time, and there resulted small canker-like areas. Later the injury was partly obscured by callus healing of the bark, so that eventually much of the injury will disappear or show merely in irregular growth at these points. The chief injury of course was the severe marring of the fruit, also opening the way for various rots, so that it was of little or no value.

Among the shade trees showing evident injury were red and hard maples, ash, sycamore, hickory, wild cherry and elm. The cankers were most evident, of course, on the smaller more tender branches with smooth bark, but could also be seen on limbs several inches in diameter. They were almost always longer lengthwise of the twigs and varied from one-half to one and a half inches long by a quarter to half an inch wide. Specimens collected

late in the fall by Mr. Stoddard showed most of the cankers completely healed over.

Ice Injury results chiefly from the breakage due to the unusual weight of the ice which is often many times that of the weight of the branch which is encompassed especially on the smaller twigs. Mr. Zappe of this Station records a case in the New Haven storm, referred to later, where the ice was 30 times that of the branch. Whether injury also results from the freezing of the sleet on the twigs is doubtful, though injury of this kind, especially to evergreens or tender deciduous trees, might result. Some believe that the ice acts as a lens in strong sunlight and burning of the enclosed tissues results. If any heating or stimulation of the tissues occurs, the injury probably results from the later freezing at night. It is also uncertain whether the cold of the icy coating causes any more harm than the dry cold on the uncoated branches.

The severe ice storm early in February, 1924, caused unusual damage to ornamental trees in the southern part of the state, especially in the vicinity of New Haven. The ice in this case stayed on the limbs for nearly a week. In the early winter of 1921, a severe ice storm occurred in northern Connecticut and Massachusetts, and caused unprecedented injury to shade trees, besides great damage to fruit trees and especially to telephone, telegraph and electric wires. The financial burden to the towns just in clearing up the rubbish from the trees and on the streets was very heavy. Some idea of the damage wrought by this storm is shown by the photograph, in Plate X, a, which was taken near Pomfret, Conn.

Wind Injury is common with most storms, breaking off the dead branches and those weakened from disease first. With very severe storms, large branches of the healthy but unprotected or soft wooded trees are blown down. The worst injury occurs when the heavy wind accompanies an ice storm. The wreckage from the ice storm at New Haven in 1924, while great, was much less than it would have been had a strong wind occurred during the five or six days that the ice was on the trees. (See Plate IX.)

Animal Injury is most common on street trees. The gnawing of the bark by horses hitched near the trees used to be a very common occurrence, and there are still in evidence large canker-like areas on many of our street trees caused by the repeated injuries they have received in the past. Now the automobile seems to have replaced the horse somewhat as a cause of barking trees. Injury by mice, especially at the base when long covered by snow in winter, occurs prominently in some years, but not in well kept yards. In orchards, nurseries or isolated places along the roadside it is not infrequent and may be quite severe.

Of all the animals, man leads in the mechanical injuries he

inflicts on trees. The cutting off of branches to allow passage of telephone and electric wires is a common occurrence, but not nearly so obnoxious as formerly because done in a more scientific manner. Changing the soil level, cutting off interfering roots for laying walks and pavements, and grading and digging for lawns and buildings are other common causes of injury. Improperly moving and transplanting large trees also often results in a sickly growth or their final death.

Bleeding, Sour Sap, Slimy Flux: *Bleeding* usually results from some mechanical injury but under ordinary conditions stops of itself. This was the case with the maples following the recent ice storm in New Haven, as the injury occurred about the time active sap flow was starting. The dripping from the broken twigs occasionally formed icicles during the night, or frequently made a wet spot on the sidewalk that was still evident long after it dried out. Of course some food, as sugar, etc., was lost to the trees in this way, but this injury was negligible.

Bleeding may also start as a result of pruning or cavity work and in the elm, from whatever cause, it is sometimes very difficult to stop. The loss of the water or sap, while undesirable, is not the evident evil here. The food in the sap affords a fine opportunity for the development of bacteria and *Sour Sap* results. This leakage may in time become a soft slime through the presence of both bacteria and yeast fungi. Good examples of this, as *Slimy Flux,* can be seen on the stumps of yellow birch that are cut in late winter or early spring. In any case, this infected sap, covering the healthy bark, is likely in time to kill the cambium and decay of the bark results. Leakage is frequently prevented or stopped by searing over the exposed sap wood with a hot iron. Again the drip is sometimes successfully carried away from the bark by a protruding iron pipe in the filling. There are cases, however, where bleeding and injury result despite all precautions.

Treatments: *Watering.* For all of these injuries spraying, of course, is of no value. With valuable trees where drought is long and severe, watering is helpful. This must be kept up, however, until the danger is past. It should not be of the frequent sprinkling type, as given to lawns, but rather an occasional good soaking in which the water penetrates deep into the soil. This may be aided by drill holes around the trees in which the hose is inserted.

Fertilizing. Where injury is manifest but the tree is still vigorous enough to save, whether the injury is due to drought or winter, fertilization, especially of deciduous trees, may be employed. One must use care, however, that this is given early enough in the season so that the tree may properly mature its wood and buds before winter sets in. Manure can be used with less impunity in this respect than most chemical fertilizers. The

quickest action is obtained with the use of nitrate of soda; this can be placed in drill holes in the ground, about 10 feet apart with large trees, around the spread of the branches and washed in with a hose. From one to 10 pounds, according to the size of the tree, may be used. A complete fertilizer scattered broadcast over the ground is sometimes used to increase the general vigor of the tree. Dr. Jenkins has recommended, in the past, the following: Nitrate of soda, acid phosphate and muriate of potash, each five parts by weight, to be mixed not more than a week before using and to be spread broadcast, one-half pound to each 50 square feet of ground, in two applications one month apart in the spring.

Pruning, etc. With the preceding tree injuries, of course, one of the first treatments consists in removing seriously injured and dead branches, and protecting the cut and exposed surfaces. The trimming should be done with reference to preserving or renewing the symmetry of the tree. Bark loosened but not torn off may sometimes be grown back by nailing to the tree, if done immediately and protected from drying out. If dead it should be cut back to the living tissues to prevent decay and to favor proper callus formation. Sometimes cavity work may be necessary, especially later if wood rot starts.

FUNGOUS DISEASES

While the injuries caused by fungi may be as conspicuous as those caused by insects, nevertheless, the general public is not so often microscopic in size, and usually not readily differentiated well acquainted with their causal agents, since the fungus is from the injury itself. They have, on the other hand, this advantage to the scientist—they do not fly away after causing the injury but stay there permanently, though they are not always easily determined individually because the fruiting stage is often late in maturing. To understand fungi and the injury they cause, it is desirable to know something of their general, as well as their specific, nature. We give this information briefly in the following paragraphs:

Nature. Fungi are the lowest forms of plant life. They differ from all other plants in lacking the green coloring matter, characteristic of leaves known as chlorophyll. Lacking this they cannot manufacture from water, gases and the chemical constituents of the soil, their food. This they must obtain in an organized form from products of living or dead plants or animals. If from the living, they produce disease as a result and are called parasites; if from the dead, they merely produce decay and are called saprophytes. With wood destroying fungi decay of the dead heart wood by a saprophytic fungus may, by weakening the

strength of the trunk or roots, be indirectly responsible for more injury than the parasitic form that directly attacks the living tissues.

Stages. Fungi consist of two stages, a vegetative stage that has to do with gathering their food, and spore stages that perpetuate their existence the same as the seeds do the flowering plants. The vegetative stage is usually inconspicuous and often not visible to the naked eye, as it consists of microscopic branched threads that ramify through the substratum or host, on which it occurs, in search for food. There is comparatively little difference in the appearance of the vegetative stage, or *mycelium*, of different fungi, hence the necessity of seeing the spore stages for identification.

The *spores* are formed on or near the surface of the host and are much more conspicuous and differentiated especially as seen under the compound microscope. Mushrooms and shelf fungi are the largest fruiting forms. Unlike flowering plants, fungi may have more than one kind of spores, but only one corresponds directly to the seed in that it is the result of fertilization of the sexual elements, the other kinds being of an asexual nature such as buds, tubers, runners, etc., in plants. Some spores are temporary and are merely useful in quickly spreading the fungus over the host or to new ones. Other spores are more hardy and serve to carry the fungus over unfavorable periods, such as winter. With the rusts, not infrequently, certain spore stages occur as parasites on one host and others on an entirely different host species, thus greatly complicating the life history of the fungus.

Infection. In any case the spores give rise to new individuals by germinating into threads that by later growth form the mycelium. With parasitic forms this germ tube or thread must penetrate in some manner into the living tissues in order to gain the food necessary for its growth. All preventive treatments of fungous diseases by spraying are based on killing the spores that are carried to the susceptible parts of the plants before they can gain entrance by their germ tubes into the tissues. Once inside, the mycelium is no more injured by the spray than the plant tissues on which it is placed. This makes it necessary to protect the tissues by repeated and thorough spraying as long as there is danger of the fungus gaining entrance. It also means that the fungicide must be able to kill the spores or their germ tubes but cause no injury to the plant tissues.

LEAF AND BARK FUNGI

We may include most of the parasitic fungi of trees with those that cause injury to the leaves or the bark. They are numerous and of great variety. Quite frequently each species is limited to a single kind of tree or its very close relatives. Usually the

earlier spore stages are parasitic while the later ones merely occur as saprophytes on the dead or dying tissues. We can best consider them here, grouped semi-scientifically, under the following headings: Anthracnoses, Leaf Spots, Leaf Curls, Powdery Mildews, Rusts, Blights and Cankers.

Anthracnoses: This is a general term applied to certain genera of fungi that locally kill the tissues of the leaf or the twig and ooze out their spores as inconspicuous, sticky drops on the surface of the host. The more common ones met with so far in this state are as follows:

Ash Anthracnose, *Gloeosporium aridum* Ell. & Holw., in wet years, especially along the coast, has caused considerable injury to the white ash foliage, large areas withering up or turning a light brown color.

Maple Anthracnose, *Gloeosporium saccharini* Ell. & Ev., is most likely to show on the sugar maple, but only occasionally causes conspicuous injury. It is so similar to the leaf scorch of this tree that one usually has to examine the leaves microscopically for the spores before he can be sure of the real cause.

Oak Anthracnose, *Gloeosporium canadense* Ell. & Ev., was unusually conspicuous last spring on white oaks, but, partly because it does not carry over so abundantly on the twigs, the injury is less evident than that of the sycamore. Fewer leaves are killed in the bud, and the injury is more localized as light brown dead areas on the mature leaves.

Sycamore Anthracnose, *Gloeosporium nervisequum* (Fckl.) Sacc., derives its specific name from the fact that it seems to prefer the tissue of the leaf along the main veins. It develops early in the season, often as soon as the buds begin to unfold, with the result that many of the leaves fail to develop. It can do this because its spores develop first on the young branches and are washed into the opening buds. The injury was the most severe in the spring of 1924 that we have ever seen. Some trees had all their very young leaves killed and had to develop a new crop, which, of course, resulted in a scanty foliage all summer. When seen at first it looked as if the trees were dead or doomed to die, but sycamores can stand a lot of such punishment and still survive. However, they usually look in this state as if half winter killed, because of repeated attacks. The European sycamore is much less susceptible to injury than the American.

Other Anthracnoses, of a less conspicuous nature, are those occasionally occurring on hickory, *Gloeosporium Caryae* Ell. & Dearn.; Linden, *Gloeosporium Tiliae* Oud.; Poplar, *Marsonia Castagnei* (Desm. & Mont.) Sacc.; Butternut and Walnut, *Marsonia Juglandis* (Lib.) Sacc. We even found an unusual one, more or less conspicuous the past year, on Beech, *Gloeosporium Fagi* var. *Americana* Ell. & Ev.

Leaf Spots: These are injuries of leaves very similar to the Anthracnoses, usually showing as small, circular or angular, dead spots, varying in color but occasionally occupying areas of considerable extent. They are caused by a great variety of microscopic fungi whose fruiting stages may show as inconspicuous pustules imbedded in the injured or dead tissues or as a moldy growth on the surface.

Ash Leaf Spot or Speck, *Piggotia Fraxini* Berk. & Cke., shows as small purplish specks on the upper surface of the leaves with the fruiting stage of the fungus rather prominently scattered over the lower surface as small black pustules. It is not a very important parasite. There are several other fungi that cause more definite leaf spots of the ash but are infrequently seen here.

Box Elder Leaf Spot, *Phyllosticta minima* (Berk. & Cke.) Ell., appears as grayish or reddish-brown circular spots, a quarter of an inch or so in diameter, with minute, black, fruiting pustules imbedded in the center. This leaf spot is identical with or very closely related to similar spots on leaves of various maples, *P. acericola* Cke. & Ell. On the latter, in some seasons, it is quite prominent and has been complained of as causing marked injury.

Catalpa Leaf Spot, *Macrosporium Catalpae* Ell. & Mart., shows in certain seasons as definite, rounded, reddish-brown spots an inch or less in diameter appearing suddenly on the new leaves, often rather abundantly, so that partial defoliation results. Similar spots are said to be caused by another fungus, *Phyllosticta Catalpae* Ell. & Mart., but while we have found one or the other occasionally present, more frequently a definite fruiting stage is absent and we still are in doubt as to the real cause. The Japanese catalpa apparently is most frequently attacked. Whether spraying will prove of value remains yet to be demonstrated.

Chestnut Leaf Spot, *Septoria ochroleuca* Berk. & Cke., is usually very evident as numerous, grayish, circular spots with a purplish border about a quarter of an inch in diameter. The fruiting bodies are more evident beneath as small, embedded, blackish specks. This trouble, on account of the rarity of its host as a shade or forest tree, is now seen only occasionally on sprout growth.

Elm Leaf Spot, *Dothidella ulmea* (Schw.) Ell. & Ev., known also as *Gnomonia ulmea* (Schw.) Thuem., forms minute black eruptions, somewhat clustered together in small circles or scattered over the whole upper surface of the living leaves. In time there is a whitish or grayish margin around these groups, due to the wearing away of the epidermis. The fungus matures its spore stage on the old leaves on the ground in spring, its fruiting perithecia opening on the lower surface. When severe, more or

less defoliation in midsummer takes place. Occasionally it is quite bad, and it is usually present in a small way every year. Burning the leaves in the fall is desirable.

Hawthorn Leaf Spot, *Entomosporium Thuemenii* (Cke.) Sacc., appears as very small, angular, reddish-brown spots most frequently on the English hawthorn, grown occasionally in yards. It has been sent in for identification a few times as it causes some defoliation where bad.

Horsechestnut Leaf Spot, *Phyllosticta Paviae* Desm., seems to occur largely on the European species commonly grown in this state. Some years, like 1922, it is very injurious and again, like the present dry year, comparatively inconspicuous. It is one of the most injurious of our leaf spot diseases of trees, since the reddish-brown dead areas often cover a considerable part of the leaves. Most of the leaves of the tree are infected and early defoliation occurs. It looks very much like a sun scorch. The tree itself does not seem to be so seriously injured as might be expected, since the next year it usually starts out with a full crop of leaves. Besides spraying with Bordeaux, raking up and burning the leaves is desirable.

Maple Tar or Black Spot, *Rhytisma acerinum* (Pers.) Fr., as its name indicates, shows as a black spot on the upper surface of the leaf much resembling a finger print. The tissues involved are somewhat thickened and slightly raised above and are concave and lighter colored below. Many of these spots are often crowded on the leaf. An inconspicuous summer spore stage is said to develop in these spots but the mature stage does not appear until the following spring, on the dead leaves on the ground. Soft maples, especially the cut-leaf form, are especially subject to attack. The fungus also is common on the red maple. Burning the leaves in the fall, or when they drop prematurely, is recommended.

Leaf Curls: These produce a thickening of the leaf tissue, together with a cupping or other slight distortion, and, occasionally when involving buds or fruits, form a bag-like enlargement. They are found chiefly on fruit and forest trees. The infected tissues are often whitish or flesh colored.

Oak Leaf Curl, *Taphrina caerulescens* (Desm. & Mont.) Tul., is about the only conspicuous form occurring on ornamental trees, where we have noticed it common the past few years. It produces a cupped thickening of the leaf tissues an inch or less across, often several occurring closely placed over the leaf. The upper surface is light colored while the lower reveals a grayish-purple growth of the fruiting stage. The same tree often shows the trouble year after year, indicating that it might be carried over on the young branches though it is said not to be perennial. Here

is another case where burning the fallen leaves might prove helpful. A related species, occasionally found on the elm, is *Taphrina Ulmi* (Fckl.) Joh.

Powdery Mildews: These differ from most of the other disease producing fungi in that almost all of their mycelium, as well as their fruiting stages, is exposed on the surfaces of the tissues, only short sucker-like threads penetrating these to extract the food necessary for growth. They consequently form a whitish cobweb-like growth more or less evident to the naked eye. The small blackened dots embedded in this growth are the mature fruiting bodies, or perithecia. Under the microscope these show numerous appendages radiating out from the central spore case. Quite a few trees, as well as shrubs and herbaceous plants, are attacked by these mildews, chiefly on the leaves, but rarely serious injury results to the ornamental trees. The following may be briefly listed:

Catalpa Powdery Mildew, *Microsphaera elevata* Burr., is considered by some as not distinct from that on oak or chestnut. It shows as a rather inconspicuous whitish growth, most commonly on the upper surface of the leaves.

Chestnut, Oak, Powdery Mildew, *Microsphaera alni* (Wallr.) Wint., attacks a wide variety of trees and shrubs, both cultivated and wild. Usually there is a conspicuous, cobweb-like coating, most frequently on the upper surface of the leaf, and in this are finally seen the numerous, small, black, spore-bearing receptacles.

Maple, etc., Powdery Mildews: *Uncinula circinata* Cke. & Pk., on the hard maples, usually forms a rather inconspicuous mycelial growth in spots on the leaves, with few perithecia; *U. flexuosa* Pk., on horsechestnuts, has a similar but more general growth over the whole leaf surface; while *U. Salicis* (D.C.) Wint., on willows, is apt to be very evident and with a great abundance of perithecia. All these species, as the generic name (*Uncinula*) indicates, have appendages hooked at the end.

Rusts: These are the most interesting and destructive of all fungi because of their several spore stages, some of which occur on entirely different hosts, and because in all stages they are strict parasites. They usually form dusty, erumpent, small pustules, more or less thickly scattered over the infected tissues. The earlier spore stages are generally a yellow or orange color, and the later a red- or black-brown. Seen by the naked eye, they are not apt to be confused with any other fungi, except the smuts which do not occur on trees. Not only do the rusts cause serious injury to trees, but they are among the most destructive parasites of all kinds of plants, particularly the cereals. Because the different stages frequently inhabit different hosts and their relationships were or are not known, scientific names have been given to the

earlier or immature stages that apply only to them, while the name given to the latest, or mature stage, not only applies to it but to all of the stages. For example:

Ash Rust, *Aecidium Fraxini* Schw., is the early stage of a rust that has the repeating and mature stages, known as *Puccinia Fraxinata* (Lk.) Arth., on marsh grass. Therefore the most complaint of injury to ash trees in this state is in the vicinity of the Sound, where marsh grass is common. The rust not only attacks the leaves, petioles and young twigs but also the winged fruits of the ash. It occurs in the cluster cup stage projecting above the tissues as minute, aggregated, toothed receptacles filled with orange colored spores. The infections give rise to some swelling and distortion of the invaded tissues.

Flowering-Crab Rust, *Roestelia pyrata* (Schw.) Thax., is a stage similar to the preceding, on apple leaves, but differs chiefly in having the cluster-cups fringed with hairs rather than toothed. Its mature stage occurs in the jelly-like horns, formed during wet spring weather, on the so-called "cedar apples" of the red cedar. The flowering crab is one of the most susceptible hosts attacked, though the Wealthy variety of apples is about as bad.

Mountain-Ash Rust, *Roestelia cornuta* (Pers.) Fr., is similar to the apple rust. It is rarely found here and has its mature stage on the juniper.

Poplar Rusts: *Melampsora Medusae* Thuem. is not infrequent on the Carolina poplar, showing, in its repeating stage, as minute yellow pustules and, in its mature stage, as reddish blisters, on the under surface of the leaves. Its earlier stage occurs on the larch. A very similar rust, known as *Melampsora Abietis-canadensis* (Farl.) Ludw., occurs on the large tooth aspen and has its earlier stage on the cones and leaves of the hemlock.

Willow Rusts, *Melampsora Biglowii* Thuem. and *M. americana* Arth., are very similar rusts on the leaves of these hosts, and have their earlier stages on the larch and balsam.

White-Pine Blister Rust, *Peridermium Strobi* Kleb., is the rust that was accidentally imported from Europe some years ago and against which such united effort by government and state officials has been expended to prevent its further spread in this country. The stage on the white pine is the early one, showing as conspicuous white blisters that soon rupture and disclose the orange powdery mass of spores. These carry the fungus to *Ribes* species, currants and gooseberries, and form there the later stages known as *Cronartium ribicola* Fisch. de Wald. On the latter hosts there is formed, first, the repeating stage, showing as small powdery pustules whose spores spread the fungus on these hosts during the summer and, finally, the mature stage, short hair-like spores that carry the rust back to the pine needles in the fall.

The injury to the currants and gooseberries is not serious, though frequently causing defoliation, but to the pine, because of its perennial mycelium, the rust eventually girdles the trunk or branch and causes its death. The disease is controlled on ornamental trees by isolation from *Ribes* and by cutting off infected branches some distance below the infested place. In plantations, eradication of all *Ribes,* within and nearby, is advocated. A similar rust on several two- and three-needle pines, *Peridermium Comptoniae* Arth., in this state, has its mature stage, *Cronartium Comptoniae Arth.,* on sweet fern.

Other Rusts, occurring on ornamental trees here but never causing serious damage, are: *Gymnosporangium Juniperi-virginianae* Schw., on cedars, mature stage of *Roestelia pyrata* (Schw.) Thax., *q. v.; Peridermium acicolum* Underw. & Earle and *Peridermium delicatulum* Arth. & Kern., on pitch pine needles, mature stages on goldenrod and asters known as species of *Coleosporium; Peridermium Peckii* Thuem., on leaves of hemlock, mature stage on huckleberries and blueberries known as *Pucciniastrum Myrtilli* (Schum.) Arth.; *Caeoma Abietis-canadensis* Farl., on leaves and cones of hemlock, mature stage of *Melampsora Abietis-canadensis* (Farl.) Ludw., *q. v.*

Bacterial Blights and Galls: These diseases are not common on ornamental trees, though a number have been found on fruit trees. Their cause, as indicated by the above title, is bacteria, the smallest of living things, which are so destructive to other plant life and are responsible for many of the contagious diseases of animals.

Crown Gall, *Pseudomonas tumefaciens* (S. & T.) Stev., as its name indicates, produces galls on the trunk and roots and occasionally higher up on the limbs of a great variety of trees, as well as of shrubs and herbs. So far we have found it on ornamental trees only on poplar and willow. The obvious treatment is to cut off the infected limb some distance below the gall. When on the main trunk, cutting out the infected tissues is of doubtful value.

Mulberry Blight, *Pseudomonas Mori* (B. & L.) Stev., produces small, watery, reddish-brown areas on the leaves and cankers usually on the younger twigs. It is rarely met with.

Fire Blight, *Bacillus amylovorus* (Burr.) De Toni, while common on such fruit trees as pear, quince and apple, has only been seen once on trees grown for ornament. In this case it was quite prominent on the English Hawthorn. The young twigs are killed back for a foot or more, the blackened leaves still adhering. Infection takes place chiefly at blossoming time. The bacteria are carried there accidentally by bees, etc., and multiplying in the nectar of the blossoms, work downward through the tender

issues of the twigs. More rarely large branches are killed hrough cankers in the bark. Cutting off the infected twigs, vhen dormant, some distance below the diseased tissue and wiping the pruning tool each time with a cloth saturated with carbolic acid or corrosive sublimate, to kill adhering germs, has been he common method for control.

Cankers: When a fungus enters a branch or trunk of a tree, t usually becomes perennial there and, gradually killing the bark, nakes a cankered spot which, if it encircles the branch, causes leath of the parts above. Fortunately, few of the fungi thus nvade large limbs or the main trunk.

Chestnut Blight, *Endothia parasitica* (Murr.) Anders., is one f these canker fungi that has proved destructive in this way. ts action has been unique in tree history in this state, as it has ractically eradicated not only all forest chestnuts but ornamental nes as well. All that are left are the sprouts that come up from he cut trees and occasional small seedlings, both of which are till subject to attacks. Treatment of any kind, so far, has been nsuccessful with this disease. This and the forestry department, however, expect soon to start small seedling plantations for uture observation.

Poplar Cankers, *Dothichiza populea* Sacc. & Bri., is another, pparently European, importation that has recently been producing havoc with our ornamental poplars, especially the Lombardy. Not all the injury, however, is due to this fungus, as insects and winter injury have played their part. The remedy for this trouble eems to be to start with a young tree entirely free from the disease, as we have seen large isolated trees that continue to escape ny injury.

Nectria Cankers, *Nectria cinnabarina* (Tul.) Fr., and *N. galligena* Bres., are apt to produce more localized cankers, especially he latter. The former, in our opinion, is not a serious trouble as t seems to follow winter injury only, and is especially prominent n those trees least hardy. The clustered bright-red fruiting ustules are conspicuous on the dead bark. The latter species nakes a distinct canker that slowly enlarges year after year, in ime showing a series of concentric rings of denuded wood with he canker deepest at the center. It is especially prominent on lack birch in the woods but is occasionally found on cultivated rees of this species as well as on apple, maple and oak.

Treatment: Treatment of leaf destroying fungi by spraying epends upon prevention rather than cure. Hence the sprayings must begin before infection and continue while this danger lasts. his usually takes from two to five treatments according to the isease. With the anthracnoses and leaf curls, these treatments sually have to be started quite early, in some cases as soon as the uds begin to swell in the spring; with the leaf spots and mil-

dews, some time in the late spring or summer, before the first signs of injury show. With rusts, spraying is usually of little or no value. In deciding whether spraying is desirable, one must take into consideration how injurious or obnoxious the fungus has proven, especially the preceding year, and how frequently it causes trouble. The 4-4-50 Bordeaux mixture, on the whole, is the best fungicide to use; in some cases where conspicuous sediment is objectionable, commercial lime and sulphur, 1 to 50 gallons of water, can be used. When necessary, an insecticide can be added to either. See the Station's Spray Calendar for further information.

Treatment for the Blights, Cankers, and Blister Rust is chiefly, as already indicated, through pruning off the invaded parts. Occasionally, under certain conditions, spraying is also given.

WOOD DESTROYING FUNGI

Nature: Almost all of the wood destroying fungi, whether on living or dead wood, belong with that class known as shelf fungi and toadstools. These represent the larger and more conspicuous fungi. Some of them are real parasites on the trees, killing the living tissues first and later causing decay of the dead wood; others are saprophytes, occurriug only in the heartwood and causing its decay. Many, while not strictly parasites, are semi-parasitic as they cause some injury to the living tissues though usually confined to the dead. Therefore, it is not always easy to distinguish the parasitic from the saprophytic forms. We treat them together here, dealing, however, only with those saprophytic forms, that, in our experience, commonly occur on the dead wood of living ornamental trees. Most of the fungi discussed belong to that group known as Polypores, so-called because their spores are borne in pores that form the lower surface of the conspicuous fruiting bodies. Some have their spores borne on spines, teeth, gills, etc. Many other species are more prominent as agents of decay in dead forest trees than those mentioned here. There are others that are more important as parasites of living trees, but we have not met with them on ornamental trees in this state.

Trunk Forms: *Daedalea quercina* (L) Pers. confines itself largely to oaks and is rarely seen fruiting on living trees though on dead stumps in the forest it is common. It occasionally causes a heart rot of the ornamental oaks even if rarely fruiting on the same. The fruiting body shows as a conspicuous bracket, light brown in color and of a semi-corky texture. The lower fruiting surface has very large irregular or labyrinthiform pores.

Fomes applanatus (Pers.) Wallr., like all the species of the genus *Fomes*, is a perennial fungus developing a new poroid fruiting layer each year over that of the preceding year, so that when

cut through these show as a series of stratified tubes. This species is one of the largest and most common of the shelf fungi. It is not found fruiting on living trees as commonly as on the dead ones. The woody shelf varies in size from a few inches to even a foot or more in width, and projects out from the trunk horizontally almost as far. Its upper surface is a light brown and its fruiting surface is white, minutely poroid and easily etched; the tissues within are chocolate-brown. We have found it occasionally on living maples, poplars, willows, apples and peaches, and believe it to be the common heartwood rot of the maple.

Fomes connatus Fr. is a whitish, semi-fleshy or finally somewhat woody, species less than a foot wide and consists usually of several irregular shelving and overlapping brackets. The fruiting surface develops flesh-colored, small, thin-walled pores having a satiny lustre. We have found it fruiting on hickory and hard maple where it caused heartwood rot.

Fomes igniarius (L.) Gill. is a single, woody, roundish to hoof-shaped bracket four to eight inches wide. It is at first light brown and smooth above but with age dark brown and more or less concentrically zoned and rimmed. Below, the minutely poroid surface is a rusty-brown color. It has been found on oaks and apples, where it seems to injure somewhat the living tissues as well as cause rot of the wood.

Polyporus squamosus (Huds.) Fr. is a semi-fleshy mushroom-like fungus with a side stem. The upper surface is covered with conspicuous patches of rusty scales and the lower is coarsely poroid. It has been found a few times on living maples where heart rot was present.

Polyporus sulphureus (Bull.) Fr. is a striking species with adhering and overlapping brackets of considerable size that are at first fleshy but on drying corky in texture. The upper surface is orange-red while the lower is a sulphur-yellow with moderate sized pores. While commonly a saprophyte on stumps and logs, at times, it is parasitic on living trees especially, as seen here, on oak.

Polystictus conchifer Schw. is a small, papery, conch-like species found on elm limbs where it produces slow rot and causes the branches to break off easily in storms. Some writers consider it semi-parasitic.

Pleurotis sapidus Kalch., *P. ostreatus* Jacq., oyster mushroom, and *P. ulmarius* Bull. are all evident, fleshy, gill fungi of the mushroom type. The two former occúr as large, usually clustered or overlapping, brackets with the individual parts narrowed backward to a more or less distinct base down which the gills run for a short distance. The last species consists of a single fruiting body with a much more pronounced stem, arising near the center of the cap, to which the gills are attached by a notch. All are white forms with the tops often more or less brownish, especially

toward the center. They are most frequently found on the elm and hard maple and are associated with a heart rot of the wood. All three species are edible.

Hydnum septentrionale Fr. is a very conspicuous but rather uncommon, semi-fleshy when young but leathery when old, bracketed form with the overlapping irregular shelves joined to the trunk by a united but not distinct base. The tops of the shelves are whitish, often somewhat scabrous and the lower fruiting surfaces are differentiated quite markedly from other fungi by the very crowded, pinkish, fine, fruiting spines about half an inch in length. It has been found here, so far, only on hard maple and hickory and is apparently semi-parasitic.

Root Forms: It is not always easy to determine whether roots have been killed by these larger fungi, since the fruiting bodies are not usually present. Even when either the mycelial threads or the fruiting bodies are seen it is still a possibility that the fungus is a secondary agent following winter or some other injury. The only two species we have found here apparently injuring the roots of ornamental trees are of the toadstool type.

Armillaria mellea (Vahl) Quel. is the most important of the mushrooms attacking the roots of living trees. The umbrella-like cap is usually a honey-yellow with patches of brownish scales; the gills are white and the central stem has a more or less evident ring. They occur in clusters on the ground with the mycelium forming conspicuous, dark colored, rounded strands running over the roots and flattening out under the bark where the woody tissues are invaded. It is more likely to attack coniferous than deciduous trees.

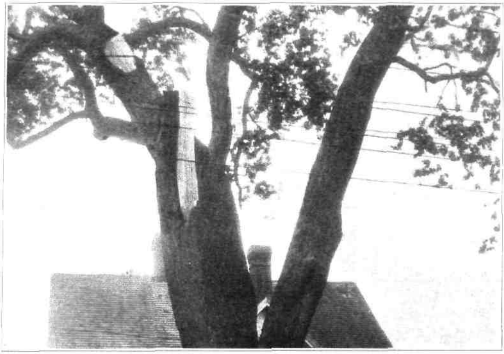
Collybia velutipes Curt. is a yellowish to tawny mushroom, somewhat smaller than the preceding, that is especially distinguished by the velvety brown stems of the clustered fruiting bodies. It is claimed by some to cause injury to the roots of trees though commonly found on dead wood.

Treatment: For further statements concerning the control of wood-destroying fungi, the reader is referred to the articles by Collins and Filley elsewhere in this Report. We shall mention here only the fundamental requirements. The first is the complete removal of all decayed or infected wood and bark to prevent, or at least to arrest, further decay. The exposed wood is usually given an antiseptic and waterproof coating or coatings. The cavity should be properly shaped and the bark so left that rapid callus formation is favored. Whether or not the cavity should be filled is a matter of opinion, but, if filled, there is no question that it should be done properly. This means that the filling should be permanent, semi-flexible, waterproof, non-injurious to the living tissues, especially the cambium layer, tight fitting or better adherent to the wood, and so shaped that the callus readily grows over its exposed surface.

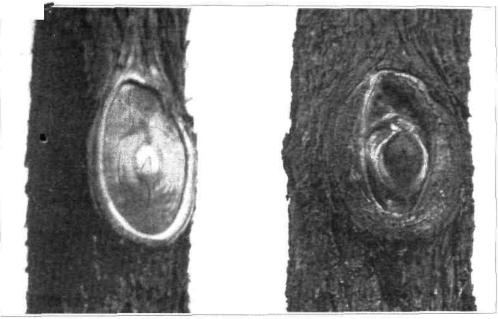
Black oak on Station grounds, broken by ice on February 5, 1924. A tree surgeon is needed in such a case.

PLATE X

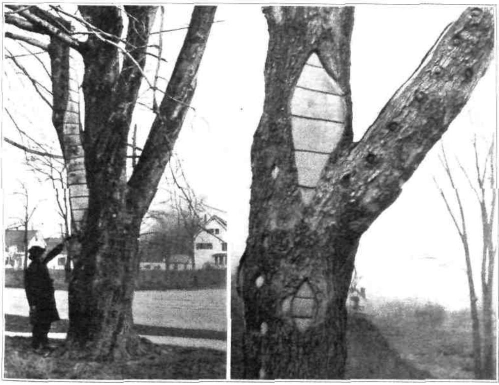
a. View in Pomfret where trees were broken by ice storm of November 27–30, 1921. This scene also justifies the tree surgeon. Photograph December 6, 1921.



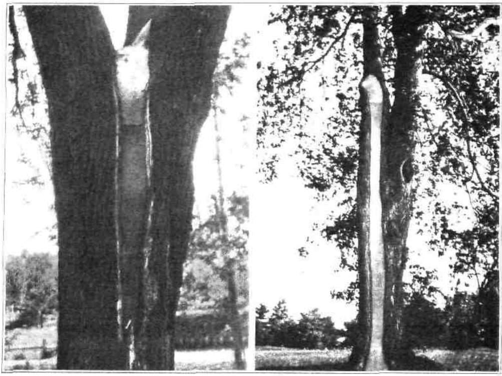
b. Elm tree in Mount Carmel, showing bad pruning. Cavities usually follow such careless work. All cuts should be made close to the trunk or branch. Photograph 1909.



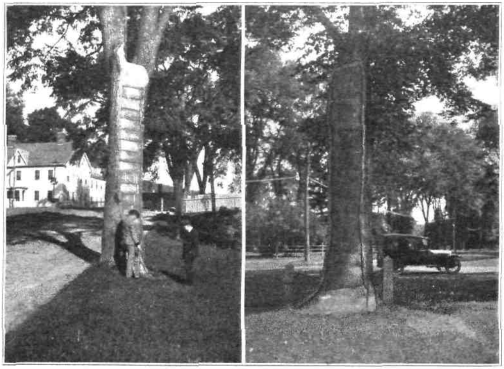
a. Young elm tree in Pomfret, where a large branch had been removed the preceding year. This was a good cut, and healing is well started. Photographed in 1909.
b. The same wound four years later. Photographed in 1913.



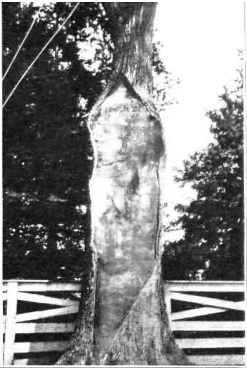
c. Large red maple in Bridgeport injured by fire. Cavities were filled with cement concrete in sections.
d. Sugar maple near the preceding, Bridgeport.
The work on both trees was overdone. The bolts were so near together that the cambium died between them.



a. Elm tree, Stamford, filled with "Nu Wud". Cambium dead at bottom of cavity. Filling has since been replaced. Photographed August 26, 1924.
b. Elm tree, Greenwich, filled with "Nu Wud". Photographed August 25, 1924.

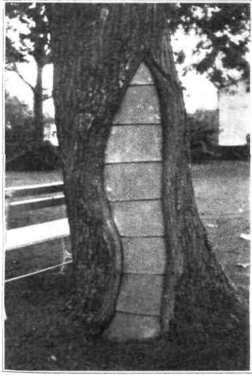


c. Elm tree at Baltic filled with cement concrete in sections. Photographed September 13, 1919.
d. Elm tree at Old Lyme injured by fire and filled with cement concrete not in sections. Photographed September 12, 1919.



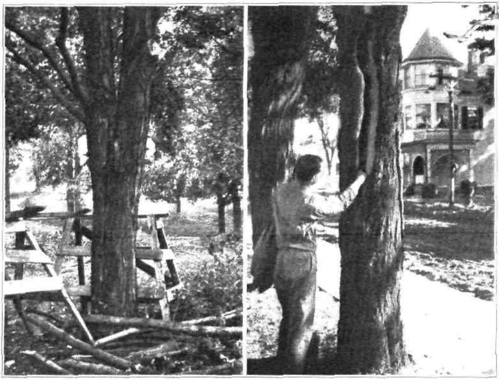
a. Large double elm, Westport, where one-half was broken away in a storm. Resulting cavity was filled with stone and brick and covered with a layer of cement, which has now broken apart. A home-made filling. Photographed August 26, 1924.

b. Elm in Greenwich where cavity had been filled with monolithic cement concrete. Photographed August 25, 1924.

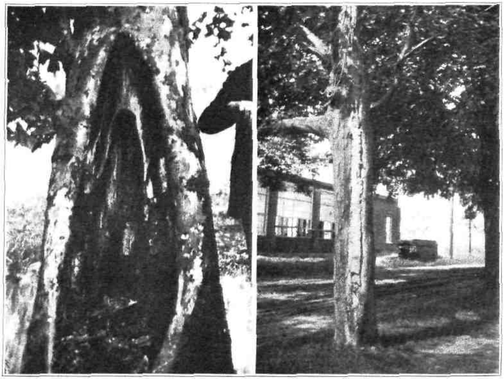


c. A satisfactory filling of sectional cement concrete in oak, Sound Beach. Photographed August 26, 1924.

d. Large white oak at Rye, N. Y., filled with sectional cement concrete. This is rather unsatisfactory, as filling is broken somewhat and new tissue has been killed at base. Photographed August 25, 1924.

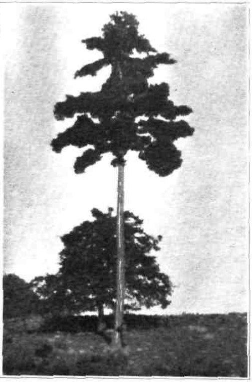


a. This splitting tree, a sugar maple, Cheshire, has just been bolted. Photographed August, 1920.
b. Example of poor cavity work in a sugar maple, Goodyear. The filling has mostly fallen out. Photographed September 13, 1919.



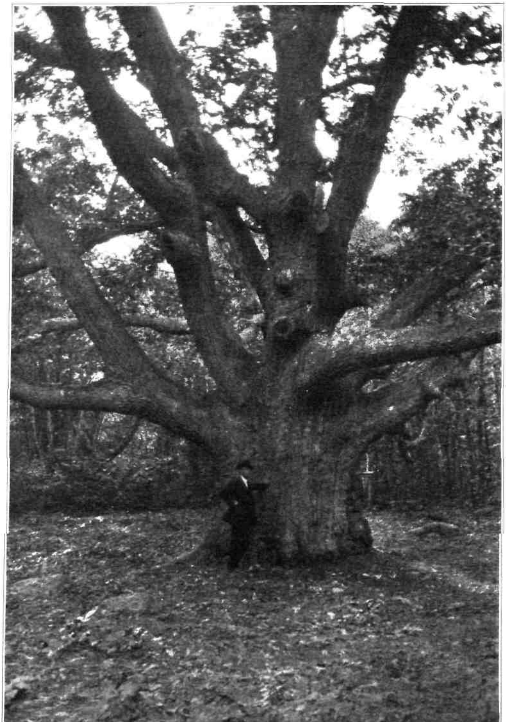
c. Open cavity in large sycamore, Bronx Parkway, N. Y. Unsatisfactory because decay sets in back of the waterproof coating. Photograph August 25, 1924.
d. Unsatisfactory filling of monolithic cement concrete. This filling was put in over the bark and is now being pushed out by new growth. Sugar maple tree in Hamden. Photographed in 1909.

a. Elm in Wallingford where curious shaped cavities (possibly cankers) have been filled. Photographed in 1912.
b. Large elm, Stamford, filled with sectional cement concrete. There is a white exudation near the base and the bark has been killed. Photographed August 25, 1924.



c. Elm in New Haven, showing cankers on the trunk. Photograph August 27, 1924.
d. White pine in Cornwall, struck by lightning, showing scar on trunk. Photographed September 13, 1917.

PLATE XVI



Giant white oak on farm of Dr. C. B. Graves, Ledyard. This tree has survived for at least 300 years without the aid of a tree surgeon.

BULLETIN 264 JANUARY, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

Report of the Director

For the

Year Ending October 31, 1924

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

As of
October 31, 1924.

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Charles R. Treat, *Vice President* .... Orange
George A. Hopson, *Secretary* .... Mount Carmel
Wm. L. Slate, Jr., *Director and Treasurer* .... New Haven
Joseph W. Alsop .... Avon
Elijah Rogers .... Southington
Edward C. Schneider .... Middletown
Francis F. Lincoln .... Cheshire

STAFF.

E. H. JENKINS, PH.D., *Director Emeritus.*

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Forestry.	WALTER O. FILLEY, *Forester in Charge.* A. E. MOSS, M.F., *Assistant Forester.* H. W. HICOCK, M.F., *Assistant Forester.* MISS PAULINE A. MERCHANT, *Stenographer.*
Plant Breeding.	DONALD F. JONES, S.D., *Geneticist in Charge.* P. C. MANGELSDORF, M.S., *Graduate Assistant.*
Soil Research.	M. F. MORGAN, M.S., *Investigator.*
Tobacco Sub-station at Windsor	———— ————, *In Charge.* N. T. NELSON, PH.D., *Plant Physiologist.*

Report of the Director

FOR THE YEAR ENDING OCTOBER 31, 1924.

To the Board of Control of the Connecticut Agricultural Experiment Station:

The year under review has been one of satisfactory progress. Detailed reports on all departmental work are presented in later pages. Here follows a very brief mention of the most outstanding accomplishments of the year.

"DEFENSE" (CONTROL) WORK.

In protecting the people of the State by analyzing fertilizers, foods, drugs and insecticides, the analytical laboratory renders one

Fig. 1. Gipsy Moth Control—Creosoting Egg Mass.

of the most valuable services that the Station offers. Although not spectacular the work of the chemist is a highly important factor in the agricultural life of the State and in the protection of public health. In 1924, 880 samples of fertilizers, 352 samples of feeding stuffs and 1,800 samples of foods and drugs were examined in addition to many other materials collected or submitted.

Seed testing is an important project of the Botany department as is also the plant disease survey, which aims to discover any new or old diseases as soon as they appear within our boundaries.

The State entomologist, who is also the Station entomologist, is responsible for all work pertaining to insect pests. He has been able to prevent damage by the Gipsy Moth and predicts that,

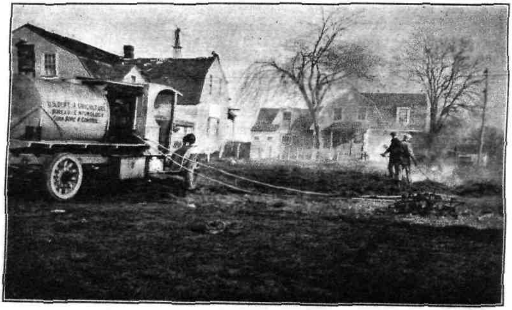

Fig. 2. Burning Weeds and Rubbish that might harbor the European Corn Borer.

within a few years, liberated parasites will automatically hold this pest in check. Like the botanist, he attempts to scout the State constantly for new insects or outbreaks of old, thus giving the citizen warning and protection. The latest invasion is by the European Corn Borer which we hope to control at the outset.

The Vegetable Proteins.

For many years Dr. Osborne and his associates have intensively studied the nature of these complex substances and many contributions to our knowledge of their nutritive value have resulted. In collaboration with Dr. L. B. Mendel and other members of the Yale faculty, studies are now being conducted on the effect of

various diets on growth, reproduction and on the occurrence of rickets.

Rickets in rats can be induced or cured at will by suitable adjustment in the diet. This study is important not only in relation to rickets in children but to leg weakness in chickens, for it has recently been demonstrated that this poultry disease is a form of rickets which can be cured by the same methods demonstrated to be successful on the albino rat.

It has heretofore been thought that too much protein in the ration injures the kidney. This, however, has not been confirmed by the experimental feeding of rats within the periods of time thus far studied. The kidneys, although enlarged, are not otherwise abnormal.

It has also been found that a diet may be entirely adequate for vigorous growth over long periods, but still be deficient in some factor which determines fertility. This fact may become important in the feeding of farm animals since it may later be discovered that the feeding of highly concentrated rations to high bred stock may be responsible for their lack of fertility.

In connection with this brief summary of biochemical investigations mention must be made of the development of methods for preparing pure protein substances in large quantities which has been the basis of past experimentation. In feeding these products to animals it has been shown conclusively that some proteins are inadequate for proper growth and development, while others possessing known or unknown characteristics are amply sufficient. The ability to prepare large amounts of pure proteins provides a sure foundation for further investigation in this field.

Spraying vs. Dusting.

In recent years there has been considerable controversy on the merits of the two methods. Experiments begun in 1920 have failed to show any sound reason for abandoning the spray programs. A combination of dust and spray applications did not give great promise in 1924, but will be continued.

Root and Ear Rots of Sweet Corn.

Steady progress is being made in developing disease-free seed by selection, the selected strain yielding 173 bushels as against 154 for the unselected seed. In the selected seed the per cent of disease has fallen from 51 to 18 in four years.

The Chemistry of Spray Mixtures.

In spite of our long experience with sprays, much is yet to be learned, especially because of the frequent addition of new materials to the mixtures. The Entomology department is engaged in a detailed study of this whole problem.

The Cabbage Maggot.

The control of this pest is still a problem. A new mode of attack involves the use of traps with proper baits, the problem being to find the aromatic substance in cabbage which seems to attract the moth.

Fig. 3. White Pines at Rainbow. Planted 1905.

The Experimental Forest at Rainbow.

Begun in 1902, these experimental plantations have now reached an age to yield valuable information. Plantings of hardwoods, with the exception of red oak, black walnut and chestnut, have failed on the coarse sand which covers the Rainbow plain. Of the conifers, the white, red and Scotch pine have made the most notable growth. It is yet too early, however, to recommend Scotch pine since it is a new type in this country.

Breeding Better Corn.

One of the notable achievements of the Station in plant breeding has been the production of a new kind of sweet corn for canners and market gardeners. By continuous self-fertilization, the corn of two different strains was reduced to a state of great purity but little vigor. To reattain vigor these two purified strains were crossed and the new corn produced.

Because of the reddish color of the leaves the corn has been named Red Evergreen. It was tested in Ontario in 1923-24 and produced six tons of ears per acre in comparison with a standard variety of Evergreen which produced only three and one half tons.

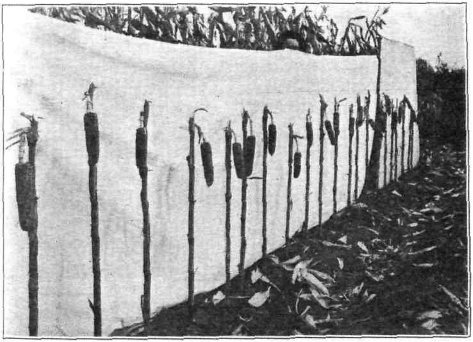

Fig. 4. Corn Produced from a Cross of Inbred Strains.—A perfect ear on every stalk.

The new corn has also been tested by several market gardeners in Connecticut and by canners in New York state with favorable results.

The method by which this corn was produced (selection in a self-fertilized line and crossing of fixed inbred strains) will be applied to other standard varieties of sweet corn.

Soils of Connecticut.

A complete knowledge of our soils must be the basis of an intelligent use of our land resources. Soil surveys of Connecticut land were begun in 1923, two towns being carefully mapped. In 1924

six areas were added and a new laboratory equipped to study the nature of each of the important soil types identified. The possible results of this work are far-reaching. The farmer who has been on the land for a generation knows his soil, but to bring together widely scattered and diverse information by means of a survey must be the task of the soil scientist. Once this is accomplished, we have not only a sound basis for land utilization and taxation but a better knowledge of how to treat those areas which are intensively planted in tobacco or vegetables.

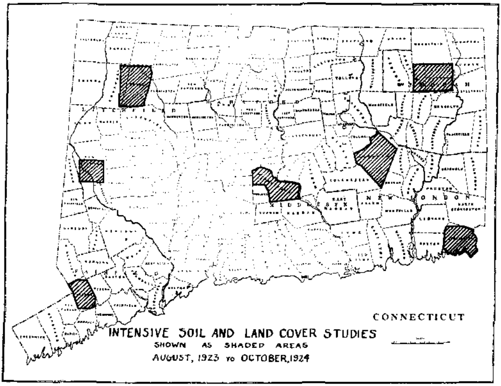

Fig. 5. Progress of the Soil Survey.

Mt. Carmel Farm Field Day.

The annual Station Field Day was held on August 11. This coincided with the field trip of the American Pomological Society and a joint program was held. President Charles L. Beach of the Connecticut Agricultural College gave the principal address.

Changes in Staff.

Appointments:

W. T. Mathis, Assistant Chemist, November 1, 1924.
N. T. Nelson, Ph.D., Assistant in Plant Physiology at Tobacco Sub-Station, April 15, 1924.
Roger B. Friend, B.S., Assistant Entomologist, Jan. 1, 1924.
Willis R. Hunt, M. S., Assistant Botanist, July 1, 1924.

Resignations:

C. M. Slagg, M. S., in charge of Tobacco Sub-Station, March 31, 1924.

Fig. 6. Field Day at Mt. Carmel Farm, August, 1924.

Publications.

Bulletins.

No. 250. Fertilizer Report for 1923.
No. 251. The Raspberry Fruit Worm.
No. 252. The European Red Mite.
No. 253. Better Forests for Connecticut.
No. 254. Report of the Director for the Year Ending October 31, 1923.
No. 255. Report on Food Products and Drugs (1923).
No. 256. Report of the State Entomologist (1923).
No. 257. Report on Commercial Feeding Stuffs (1923).
No. 258. Report on Insecticides and Fungicides (1923).
No. 259. Corn in Connecticut.
No. 260. Rust Infection of Leaves in Petri Dishes.

Tobacco Bulletins.

No. 4. Revised Recommendations for the Control of Wildfire.

Circulars of Immediate Information.

No. 28. Winter Condition of Apple and Peach Buds.
No. 29. Dormant Sprays for Orchard Pests.
No. 30. Information About Insecticides and Fungicides.
No. 31. Why and How to Spray.
No. 32. Varietal Susceptibility of Apples to Diseases and Injuries.
No. 33. The Prepink and Pink Sprays for Apples.
No. 34. Spray for the Imported Current Worm.
No. 35. Tree Workers Holding Connecticut Certificates.
No. 36. The Calyx and Later Summer Sprays.
No. 37. Peach Spraying.
No. 38. Grape Spraying.
No. 39. The Apple and Thorn Skeletonizer.
No. 40. Spraying Shade Trees.
No. 41. The Oriental Peach Moth.
No. 42. Spraying Potatoes.
No. 43. The Apple Maggot or Railroad Worm.
No. 44. The Gipsy Moth Quarantine.
No. 45. Sun Scorch, Anthracnose, etc. of Shade Trees.
No. 46. Prematuring of Vegetables, Rots of Lettuce and Similar Troubles.
No. 47. Prematuring and other Potato Troubles.

Journal Papers.

Some Basic Substances from the Juice of the Alfalfa Plant.
By Charles S. Leavenworth, Alfred J. Wakeman and Thomas B. Osborne. J. Biol. Chem., 1923., LVIII, 209-214.

Experimental Production of Rickets with Diets of Purified Food Substances.
By Thomas B. Osborne, Lafayette B. Mendel and Edwards A. Park. Proc. Soc. Exper. Biol. and Med., 1923, XXI, 87-90.

The Effect of Diet on the Content of Vitamine B in the Liver.
By Thomas B. Osborne and Lafayette B. Mendel. J. Biol. Chem. 1923, LVIII, 363-367.

Nutrition and Growth on Diets Highly Deficient or Entirely Lacking in Preformed Carbohydrates.
By Thomas B. Osborne and Lafayette B. Mendel. J. Biol. Chem., 1924, LIX, 13-32.

Nutrition and Growth on Diets Highly Deficient or Entirely Lacking in Preformed Carbohydrates.
By Thomas B. Osborne and Lafayette B. Mendel. Proc. Soc. Biol. Chem., J. Biol. Chem., 1924, LIX, xliv.

Nutrition and Growth on Diets Highly Deficient or Entirely Lacking in Preformed Carbohydrates.
By Thomas B. Osborne and Lafayette B. Mendel. Proc. Am. Physiol. Soc. Am. J. Physiol., 1924, LXVIII, 143.

The Nutritive Value of Lactalbumin.
By Thomas B. Osborne and Lafayette B. Mendel. J. Biol. Chem. 1924, LIX, 339-345.

The Vegetable Proteins, Second Edition.
By Thomas B. Osborne, Longmans, Green & Co., London, 1924, pp. xiii +154.

Ophthalmia as a Symptom of Dietary Deficiency.
By Thomas B. Osborne and Lafayette B. Mendel. Am. J. Physiol., 1924, in press.

Evidence expérimentale du manque de vitamine dans l'alimentation.
By Lafayette B. Mendel. Bull. Soc. Scient. d'Hyg. Alimentaire, 1924, XII, 29.

Nutrition: The Chemistry of Life.
By Lafayette B. Mendel. Yale University Press, 1923, pp. xii +150.

Investigation on the Nitrogenous Metabolism of the Higher Plants. V. Diurnal Variations in the Protein Nitrogen of Runner-Bean Leaves.
By Albert Charles Chibnall. Biochem. J., 1924, XVIII, 387-394.

Investigations on the Nitrogenous Metabolism of the Higher Plants. VI. The Role of Asparagine in the Metabolism of the Mature Plant.
By Albert Charles Chibnall. Biochem. J., 1924, XVIII, 395-404.

Investigations on the Nitrogenous Metabolism of the Higher Plants. VII. Leaf Protein Metabolism in Normal and Abnormal Runner-bean Plants.
By Albert Charles Chibnall. Biochem. J., 1924, XVIII, 405-407.

Some Nitrogenous Constitutents of the Juice of the Alfalfa Plant. I. The Amide and Amino Acid Nitrogen.
By Hubert Bradford Vickery. J. Biol. Chem., 1924, in press.

Some Nitrogenous Constituents of the Juice of the Alfalfa Plant. II. The Basic Nitrogen.
By Hubert Bradford Vickery. J. Biol. Chem., 1924, in press.

Pathogenesis of the Ocular Lesions Produced by a Deficiency of Vitamine A.
By Arthur M. Yudkin and Robert A. Lambert. J. Exp. Med., 1923, XXXVIII, 17-24.

Changes in the Paraocular Glands Accompanying the Ocular Lesions which Result from a Deficiency of Vitamine A.
By Robert A. Lambert and Arthur M. Yudkin. J. Exp. Med., 1923, XXXVIII, 25-32.

An Experimental Study of Ophthalmia in Rats on Rations Deficient in Vitamine A.
By Arthur M. Yudkin. Arch. Ophthalmology, 1924, in press.

Diseases of Connecticut Vegetables in 1923.
By G. P. Clinton. Rept. Conn. Veg. Growers' Assn. (1923) p. 45.

Injuries and Diseases of Connecticut Fruits in 1923.
By G. P. Clinton. Rept. Conn. Pom. Soc. (1923) p. 37.

Spraying Strawberries for the Control of Fruit Rots.
By E. M. Stoddard, D. H. Rose, and N. E. Stevens, U. S. Depart. Agr. Circ. 309, p. 1.

Will The Chestnut Trees Come Back?
By G. P. Clinton. The New Eng. Farmer, Vol. 49, p. 1.

Seed Notes.
By E. M. Stoddard. Seed World, Vol. 15, No. 11, p. 34; Vol. 16, No. 8, p. 31.

Report of Committee on Injurious Insects.
By W. E. Britton, Conn. Pom. Soc. Proceedings (1924) p. 41.

Some Insects to be Combated Next Season.
By W. E. Britton, Conn. Pom. Soc. Proceedings (1924) p. 72.

Insects Attacking Vegetable Crops in Connecticut in 1923.
By W. E. Britton, Rept. Conn. Veg. Growers' Assn. (1924) p. 43.

An Asiatic Beetle (Anomala orientalis) in Connecticut.
By W. E. Britton. Jour. Econ. Ent. (April 1924) Vol. 17, p. 309.

The Gipsy Moth and Our Forests.
By W. E. Britton. New Eng. Farms (June 21, 1924.)

Connecticut Tree Workers' Institute.
By W. E. Britton. Florists' Exch. (March 22, 1924), Vol. LVII, p. 890.

Proceedings, Shade Tree Conference.
By W. E. Britton. Florists' Exch. (Sept. 6, 1924), Vol. LVIII, p. 703.

Meeting of Connecticut Entomologists.
By W. E. Britton. Jour. Econ. Ent. (Dec., 1924), Vol. 17, p. 669.

Control of European Red Mite in Connecticut.
By Philip Garman. Conn. Pom. Soc. Proceedings (1924) p. 44.

Factors Influencing the Effectiveness of Arsenate of Lead.
By Philip Garman. Florists' Exch. (Sept. 6, 1924), Vol. LVIII, p. 685.

The Raspberry Fruit Worm.
By B. H. Walden. Conn. Pom. Soc. Proceedings (1924) p. 124.

Results of Dusting versus Spraying in Connecticut Apple and Peach Orchards in 1922.
By M. P. Zappe and E. M. Stoddard. Crop Prot. Digest. (June 1924), Bull. Series No. 4, p. 2.

Progress of Spraying and Dusting Experiments.
By M. P. Zappe and E. M. Stoddard. Conn. Pom. Soc. Proceedings (1924) p. 52.

Accomplishments in the Past Year in Anti-Mosquito Work in Connecticut.
By R. C. Botsford., N. J. Mosquito Exter. Assn. Proceedings (1924) p. 80.

Some Insect Information from a Connecticut Conference.
By W. E. Britton. Florists' Exch. (Nov. 29, 1924), Vol. LVIII, supplt. Page A.

Waxy Endosperm in New England Maize.
By P. C. Mangelsdorf. Science (Sept. 1924). Vol. 60, p. 222.

Selective Fertilization among the Gametes from the Same Individuals.
By D. F. Jones. Proc. of the National Acad. Sciences (June, 1924), Vol. 10, p. 218.

Methods for Seed Corn Production Being Revised.
By D. F. Jones. Jour. Heredity (July), 1924), Vol. 15, p. 291.

Heritable Characters of Maize (XII) Mealy Endosperm.
By P. C. Mangelsdorf. Jour. Heredity (Aug.-Dec., 1922), Vol. 13, p. 359.

The Inheritance of Defective Seeds in Maize.
By P. C. Mangelsdorf. Jour. Heredity (June, 1923), Vol. 14. p. 119.

Land Cover Studies as a Basis for a More Accurate Interpretation of the Soil Survey.
By M. F. Morgan. Jour. Am. Soc. of Agron. (July, 1924), Vol. 16, No. 7, p. 452.

Physical Equipment.

The removal of the Board of Health Laboratory to Hartford made available the lower floor and basement of the old Botany building, in which a very complete Soils laboratory has been installed. The small greenhouse has been repaired and will be used for pot experiments.

About 900 volumes were added to the library, which now contains 11,800 volumes.

REPORTS OF DEPARTMENTS.

ANALYTICAL CHEMISTRY.

Dr. E. M. Bailey in charge.

1. **Control of Fertilizers.** Eight hundred and eighty samples of commercial fertilizer have been analyzed, the results reported to the manufacturer and others interested, and the complete data classified and arranged for publication.

2. **Inspection of Feeding Stuffs.** Three hundred and fifty-two samples of commercial feeding stuffs and other fodder materials have been examined and the results published together with a discussion of the law relating to this subject.

3. **Inspection of Foods and Drugs.** Control and investigational work on food products and drugs has entailed the examination of about 1,800 samples.

4. **Calibration of Babcock Glassware.** Nearly 4,000 pieces of Babcock glassware have been checked for accuracy of calibration.

5. **Inspection of Insecticides and Fungicides.** About 70 samples of spraying and dusting materials were examined and the results published together with the text of the insecticide law recently enacted and rules and regulations for its enforcement as formulated jointly by the Director of this Station and the Dairy and Food commissioner.

6. **Studies on Methods.** Collaborative work has been carried on with the Association of Official Agricultural Chemists upon methods for the analysis of spices and other condiments and of cacao products.

7. **Analysis of Diabetic Foods.** The station has collaborated with the Council on Pharmacy and Chemistry of the American Medical Association on the subject of diabetic and special foods.

8. **Analysis of Check Samples—Cottonseed Meal and Mixed Fertilizers.** The Station has collaborated with the American Oil Chemists Society and the F. S. Royster Guano Co., in the analyses of check cottonseed meal and mixed fertilizers.

BIOCHEMISTRY.

Dr. T. B. Osborne in charge.
(In collaboration with Dr. L. B. Mendel, Yale University.)

PROTEIN RESEARCH AND NUTRITION STUDIES.

1. **A Study of the Proteins of Green Plants.** Investigations of the constituents of the alfalfa plant have been continued. New methods of fractionation have been developed and have indicated the presence in alfalfa juice of new substances, including a new base, not yet identified. A protein with no carbohydrate impurity

has been derived from cell cytoplasm of the spinach plant, by a new method of separation. Its isolation in a state of purity will be of importance in the study of the chemistry of the living cell.

2. **The Relation of the Chemical Constitution of the Diet to the Development of Rickets.** (With Dr. Park of the Yale School of Medicine.) Observations are being attempted under conditions of carefully controlled diet. Diets of purified food substances have been formulated which lead to the development of either rachitic or osteoporotic changes in the bones. It is inadvisable as yet to form generalizations from the extensive data collected.

3. **Studies of the Relation of Vitamines to Nutrition.** Experiments show that when smaller doses of protein-free vitamine B concentrate are fed to larger animals a decline in weight ensues; with intermediate doses there may be maintenance at various levels of body weight; with the larger vitamine B intake for the smaller animals growth ensues.

4. **The Part Played by Proteins, Carbohydrates and Fats in Nutrition.** (With cooperation of Drs. Park and Winternitz of the Yale School of Medicine.) The extent to which preformed carbohydrates are essential in metabolism, and the development of hypertrophy of the kidneys in protein-fed rats were further investigated. The success of varied types of experiments on diets extremely unlike those of every day experience seems to indicate that surprisingly large variations in the quantitative make-up of the diet may apparently be tolerated so long as the "law of minimum" is not violated.

5. **The Effect on the Eye of a Deficiency of the Fat Soluble Vitamine.** (With Dr. Judkin of the Yale School of Medicine.) It was found that ophthalmia occurs among rats living on "purified" Vitamine A free diets to a percentage as high as 82.

6. **The Effect of Diet on Fertility.** (With Dr. Mason of the Yale School of Medicine.) On our "standard" casein diet, which has proved adequate for growth but not for reproduction, definite degeneration of the germ cells of the testes of rats, reared from weaning on the casein diet, was recorded. Ordinary mixed diet has not restored sterile rats to a normal condition after periods of 100 days.

7. **The Relation of the Chemical Structure of the Proteins to their Nutritive Value.** Much remains to be learned concerning the part played in nutrition by the various amino-acids which proteins yield on digestion. As a preliminary to further study in this field much time has been devoted to preparing large quantities of pure amino-acids which can be used in feeding experiments.

BOTANY.

Dr. G. P. Clinton in charge.

1. **The Effect of Fertilizers, Especially Nitrate of Soda, on the Growth, Yield, Longevity and "Yellows" of Peaches.** Since it was started in 1909, records in this experiment have been kept on the health and length of life of each tree, of the growth in diameter of the trunk during the earlier years and of the yield from each during the bearing years. Since 1916 nitrate of soda has been the fertilization used on each of the nine different blocks.

Serious drought in July 1924, and later, a severe hail storm, practically ruined the season's crop. The chief causes of failures and poor crops have been winter and drought injuries, fungi and insects being secondary in importance.

2. **The Nature and Cause of Mosaic Disease of Plants.** The cause of mosaic disease still remains in doubt, altho interesting observations have been made, some of them apparently new. The experiment represents a continuation of work on Calico of Tobacco published several years ago, and is chiefly concerned with that host and the relationship of its mosaic to other hosts. The work of the past two years has been chiefly microscopic and with varied infectional experiments outdoors and in the greenhouse.

3. **The Ustilaginales of North America.** This is a supplement to the work the writer published some years ago. During the winter material was partially assembled but not completed. The work may be finished for publication during the coming year.

4. **The Rusts of Connecticut.** This is a list of the rusts, with their hosts, so far collected in this state. Their distribution is given by towns, together with the dates of collection, collectors, and occasional notes. Every town in the state is represented by one or more collections. Total collections now number more than 2,500, representing nearly 120 species and 20 genera. The manuscript for publication, including keys to the genera and species, has been partially prepared.

5. **Plant Disease Survey of Connecticut.** Altho a dry season was experienced, on the whole rather unfavorable for fungous diseases, the Disease Survey for 1924 includes more than the usual number of notes on distribution, etc. Two or three new bacterial diseases of economic plants were listed for the first time. Preliminary reports to the U. S. Bureau of Plant Industry have been made.

6. **Thielavia Basicola, a Study of the Perfect Stage.** Evidence has accumulated that the conidium-chlamydospore strains and the perithecial strains do not belong to the same fungus, altho the perithecia have been hitherto considered the perfect stage of *Thielavia basicola*. Successful crossings besides those

of *Thielavia basicola* and *Thielaviopsis basicola* have been made of asco strains with a species of *Aspergillus* and *Fusicladium pyrinum* as well as with *Cladosporium fulvum*. Crossings made with *Thielaviopsis paradoxa* failed to produced perithecia. Attempts to determine the parasitism of the asco strains have so far yielded negative results altho perithecia have been found deeply embedded in the roots of tobacco, pea and violet, but in these cases always associated with the conidium-chlamydospore stages.

7. **A Study of Pythiums.** Artificial cultures of various fungi are obtained and kept going on special media in the test tubes. These are then available for special study as desired. Pythium species obtained from about a dozen different hosts, chiefly as dampening-off fungi, are among those now being especially collected.

8. **Comparison of Spraying and Dusting on Apples and Peaches, Especially to Try New Dusts.** (Joint project with Entomological Department.) For fungi, spraying has uniformly given the better control. This year, however, the dust control more nearly approached the spraying because of dry weather which prevented the development of fungi. A test of spray and dust combination did not give marked results but it seems desirable to experiment further with combinations of spray and dust as this seems to be the way that dust may be used in the control of apple troubles.

9. **Control of Celery Blights with Sprays and Dusts.** During the past year tests were made in thirteen fields with eight different growers. Home-made 4-4-50 Bordeaux mixture was compared with Niagara Sulfodust and Niagara D25 Copper Dust, checks being kept in each test. Comparatively little blight injury occurred in the fields so that decisive results were not obtained. On the whole control and yields seem to point to the following order of the plots: (1) Bordeaux Mixture, (2) Copper Dust, (3) Sulphur Dust, (4) Check.

10. **Control of Root Rot and Improvement of Sweet Corn by Seed Selection.** This experiment was started in 1920 to determine if it was possible, by seed selection, to control root and ear rots of sweet corn grown for seed. A composite sample of seed selected from the best lines during the preceding four years was planted in comparison with unselected seed of the same strain and unselected seed of the same variety grown in the same locality from a different seed source. The selected seed gave a better stand and more even growth especially early in the season. The number of diseased ears did not differ greatly in the three plots, but the yields of selected seed were much greater. The selected seed has also shown a steady increase in average per cent of disease-free ears, determined by germination tests.

11. **Comparison of Sprays and Dusts on Potatoes.** (Joint project with Entomology Department.) Copper dust has been

compared with 4-4-50 Bordeaux mixture in this experiment. There has been no blight in three years but each year the sprayed plot has given greater yield than the dusted, and the dusted has been better than the check. The sprayed vines have shown less injury from tipburn and flea beetle injury and have lived longer than those in the dusted and check plots.

12. **Seed Testing.** This is one of the oldest lines of work of the Station and is largely routine in nature. Farmers, and others, wishing to know the germination and purity of seeds purchased, send them in for testing. Particular attention is paid to testing seed-corn for experimental purposes. At times special work is done on certain seeds. For example, grass and forage crop seeds were tested the past year to determine if their standard of purity and germination in this state compared favorably with that in other states, which seems to be the case as shown by the result of the tests.

13. **Peach "Yellows."** Started in connection with fertilizer experiments of peaches in 1908, this study has consisted, in part, of "Yellows" surveys in different orchards over a series of years. Budding and other infection experiments have also been carried on. No results have been published except general notes.

14. **Musk Melons and Blight Resistance.** Some time ago this experiment was carried on over a period of several years. It consisted in growing 100 so-called varieties for three years and in making studies on blight resistance, quality and yield with sprayed and unsprayed vines of a selected variety, Miller's Cream. The results have never been published and no recent work has been done; the fields of commercial growers have been visited from time to time.

15. **Chestnut Blight.** This subject was investigated and the results published some years ago. Renewed interest in the future of the chestnut in this state has induced the Botany and Forestry departments to take up some new phases of the subject in 1924. Surveys were made in several marked localities on the number of dead, diseased and free sprouts, seedlings and trees. Records will be kept and these plots examined again yearly. Seed was obtained and placed outdoors to grow seedlings, in part, for planting eventually under forest conditions, and, in part, for inoculation with old and new cultures of the blight.

16. **White Pine Blister Rust.** Two papers have already been published on this subject. Only a little infection work has been done during the past year. Considerable data has been obtained that has not been published. A final study may be made of assembled data during 1925 and the results published in the next report.

17. **Infection Experiments and Other Studies with Rusts.** Work along infection lines has been carried on in the past. Much of

this has been done with leaves in petri dishes. A bulletin (No. 260) on this work is now in press.

18. **Tobacco Diseases.** All field and observational work on tobacco is included under this general title. Field and greenhouse studies on black and red root rot and general notes on all tobacco troubles, including culture of the fungous ones, are the chief phases of investigation at present.

19. **Onion Diseases.** Work in the past has consisted of general notes on the troubles of this host, seed treatment for smut on infected seed, and spraying experiments against blast of the seed crop.

20. **Tree Diseases.** General forestry and shade tree work is covered in this project. A list by hosts, of all of the fungi that had been collected on either living or dead trees and their products, has been prepared. A general article on Fungous and non-Parasitic Diseases of the Ornamental Trees of Connecticut has also been written.

21. **Bud Inheritance on Yield of Peaches.** It is planned to start a young orchard with scions budded from the most prolific and healthy, as well as from the less prolific and healthy trees, which have been under observation during the past sixteen years at the Barnes Experimental Peach Orchard. This is to determine if bud selected trees from these two sources will continue to show the same differences in yields. This will indicate if it is more advantageous to select buds from high-bearing trees than to practice miscellaneous selection. Seed stock for the budding has already been grown.

22. **Influence of Root Grafts on Scions of Apples.** This is to determine the effect of root on scion (1) on Baldwin with respect to quality of fruit borne (2) on McIntosh to observe the effect of root on color of fruit. Scions will be taken from Baldwin trees that have borne good fruit on their own roots and will be placed on roots from trees that bear poor fruit. This operation will be duplicated with poor-fruited trees. The McIntosh striped and self-colored trees will be grown each on its own roots and on roots of the opposite color.

Entomology.

Dr. W. E. Britton in charge.

1. **The Life History, Habits and Control of the Plum Curculio on Apple.** Several new facts regarding the habits and life history of *Conotrachelus nenuphar Hbst.* have been learned during a study of two seasons in the five year program for the study and control of the plum curculio on apples. No satisfactory control methods have been ascertained, however.

2. **Tests of Paradichlorobenzene to Control the Peach Borer.**

3. **Comparisons of Spraying and Dusting on Apples and Peaches, Especially to Try New Dusts.** (Joint project with Botany Department.) (See Botany.)

4. **Comparisons of Sprays and Dusts on Potatoes.** (Joint Project with Botany Department.) (See Botany.)

5. **The Life History, Habits and Control of the European Red Mite.** (Inactive.)

6. **Control of Foul Brood of Bees.** Testing denatured alcohols to obtain a satisfactory product for making Hutzelman's alcohol formalin solution, in addition to comb treatment with the commercial preparation for control of American foul brood, comprised the work during 1924.

7. **A Study of the Asiatic Beetle, Anomala orientalis.** A study of this beetle was undertaken following a severe infestation of New Haven lawns. Some progress has been made in life history studies. Calcium cyanide is effective in killing larvae of the beetle but it injures vegetation and is a menace to children and dogs. Carbon disulphide is more satisfactory.

8. **The Life History, Habits and Control of the Raspberry Fruit Worm.** (Completed.)

9. **Insect Survey of Connecticut.** For four years data has been gathered on the prevalence or absence of insect pests and monthly reports have been sent to the Federal Bureau of Entomology for publication in a bulletin covering conditions in the United States.

10. **Inspection of Orchards and Nurseries.** All nurseries (116 in 1924) were inspected for insect pests. The botanist, co-operating with the inspectors, searched for plant diseases. Forty-seven orchards and gardens were inspected on request.

11. **Control of the Gipsy Moth.** State scouts covered 73 towns. Federal scouts 35 towns in 1923-24. All of the 10,007 egg clusters found were creosoted, and 327 infestations were sprayed in May and June, using 8,483 pounds of lead arsenate. Around the infestations, 6,315 larvae were destroyed besides those killed by spraying. State scouts covered 6,975 miles of road.

12. **Elimination of the Mosquito Nuisance in Salt Marshes.** Under State supervision 5,000 acres of salt marsh were patrolled throughout the season and 154,000 lineal feet of ditches recut. Salt marsh areas in Stamford were reditched and new ditching is in progress in Westbrook. Ten new iron culverts and six new iron tide-gates were installed. One dike was repaired.

13. **Inspection of Apiaries.** Among 953 apiaries, containing 8,929 colonies of bees, 17 apiaries (47 colonies) were found infested with European foul brood, and 10 apiaries (20 colonies) with American foul Brood. Directions and, in some cases, demonstrations, were given the owners regarding control.

14. **A Study of the Chemical Changes in Standard Spray Mixtures.** (Joint project with Chemical Department.) Tests of the effect which the order of mixing various ingredients has upon color, character of sediment and suitability for spraying of the spray mixture and also analyses of various combinations for water soluble arsenic to determine which combinations are best from a chemical standpoint, have yielded results which must be verified by additional chemical study.

15. **Bionomics of the Birch Leaf Skeletonizer, Bucculatrix canadensisella.** The main points in the life history have been worked out and several parasites uncovered. Work has been started on fungous diseases. Some features of morphology have been established and control measures determined. The distribution of the insect in Connecticut has been partly surveyed.

16. **Experiments with Baits Attractive to the Cabbage Maggot Fly.** The residue left from distilling an alcoholic extract of cabbage was found to be attractive when in suitable medium. This has been compared with other baits and is being developed as an efficient control measure.

17. **Life History and Methods of Controlling the Oriental Peach Moth, Laspeyresia molesta.** Threatening outbreaks late in the season of 1923 led to control studies in which nicotine dusts and sprays were tried with 50% control. A limited number of observations have been made on the life history in Connecticut and a general, observative survey of the State, supplemented with information from questionnaires sent to various growers, has been made.

18. **Life History of Imported Current Worm.** Data has been collected on egg laying habits, number of eggs laid by individuals, period of incubation, etc. Adults appeared two to three weeks late in 1924 and there were apparently only two broods.

19. **Control of the European Corn Borer.** Federal men scouted all towns along the shore, also Orange and Wethersfield and found seven infestations. State scouts covered four towns. All infested fields and some adjoining fields were burned over.

Forestry.

Mr. W. O. Filley in charge.

1. **Experimental Plantations on a Sandy Tract at Rainbow.**

a. Comparison of a wide variety of conifers and hardwoods.

b. Methods of management for those species that have survived.

c. Studies on growth and habits of the several species. These were begun in 1902. In 1924 liberation cuttings and cleanings were completed where needed, fire lines were harrowed and new plantations were started to replace discontinued or unsuccess-

ful experiments. New experiments include under-planting of red oak with red pine; plantations of white spruce and red pine in the open and replanting a burned area with white pine. A report covering the results to date is now in press. (Bul. 262.)

2. **Effect of Thinning in White Pine (At Shaker Station)—Three Grades of Thinning.**

Students from the Yale Forest School made a second thinning in two of the plots in the spring of 1924.

3. **Effect of Thinning in Hardwoods (At Quassipaug Lake).** The plots were visited in connection with other work but no measurements were taken and none are planned until 1927.

4. **Studies on White Pine Needle Blight.** No definite observations were made during the year, the season apparently not being conducive to this trouble.

5. **Distribution of Planting Stock to Small Holders at a Reasonable Price.** The department again assisted land owners in securing forest planting stock. A total of 775,000 trees, mostly two year seedlings, were distributed on 95 orders.

6. **Willow Culture (for Basket and Furniture Manufacture).** One holt was discontinued and the roots pulled up. Preparations were made to distribute a large number of cuttings but only two requests were received and only 1,000 cuttings were sent out for the cost of packing and postage. Distribution will be continued and plantings already made will be visited.

7. **Control of White Pine Blister Rust (a Control Project).** Wild currant and gooseberry bushes were eradicated from 6,000 acres in the towns of Canaan, Cornwall, North Canaan, Litchfield and Salisbury. About 20% of the cost was paid by town appropriations or private subscriptions. Educational work was carried on co-operatively with the Federal Bureau of Plant Industry by two field agents employed throughout the year. New Haven and Fairfield Counties have been covered and scouting in Litchfield County is practically completed. Eradication and educational work will be continued.

8. **Studies of Forest Plantations (Listing All Plantations and Taking Notes on Conditions, Success, Etc.).** Blister rust agents have reported on more than 7,500 acres of plantations in 81 towns, but the studies are not yet completed. During 1925 the reports of plantations will be checked and additional studies made, with the plan of publishing a bulletin on forest planting before the close of the year.

9. **Replacing Chestnut with Conifers in a Farm Woodlot.** Planted evergreens have in most cases made good growth. Another cleaning will be necessary in 1925 and it may be desirable to remove more of the overwood.

10. **Forest Soils Study.** On 116 plots, for which the soil series and type have been determined, the following data has been recorded: (1) Locality, slope, aspect, site, quality, fires, silvicultural

treatment, (2) Forest cover (main stand) tallied on 1/20 acres by species, diameter and crown class, (3) Reproduction tallied on 1/100 acre by species and by height classes, (4) Shrubby undergrowth noted as abundant, medium or scant for the 1/20 acre, (5) Herbaceous growth noted similarly to (4). No definite conclusions have been formulated from the assembled data, and plans for the coming year must await the derived results. More plots will probably be necessary to make proper correlations.

11. **Coniferous Seed Bed Study to Determine**:
   1. The value of fertilizers in seed beds.
   2. The value of different amounts of seed.
   3. The value of dusts and sprays in preventing damping off.

Thirteen seed beds were laid off on the Station grounds and were treated as outlined above. The experiment will be continued and data recorded.

Genetics (Plant Breeding.)

Dr. D. F. Jones in charge.

1. **The Inheritance of Characters in Corn.** The widespread occurrence of lethal factors producing aborted and defective grains in corn has been determined and the effect of these factors upon development is being studied as well as their mode of inheritance. A number of factors influencing the development of the floral organs and affecting the fertility of the corn plant have been located.

2. **The Effect of Inbreeding and Crossing Upon Corn.** Four inbred strains of corn self-fertilized for eight generations were separated into two lines each and continued for eight generations more. Two of these four paired lines were visibly different at the end of this period and all gave significant increases in growth when the paired members were intercrossed.

3. **Methods for the Improvement of Naturally Cross-Fertilized Plants by Selection in Self-Fertilized Lines.** Preliminary crosses were made between the most promising selected lines of Evergreen sweet corn. Crosses between various lines of early maturing dent and flint corn were grown from which a type for grain in Connecticut will be developed. Seventy-five lines of Whipple's Early Yellow Sweet Corn were started for the purpose of producing an early medium-sized yellow sweet corn of good quality for market gardeners.

4. **Methods of Improving the Naturally Self-Pollinated Tobacco Plant.** Forty-two selections from a cross of Cuban and Broadleaf tobacco have been grown. These include lines which have been one, two or three times back-crossed with Cuban. These are being selected as a shade type and being studied to determine to what extent the shade tobacco characteristics can be retained with added improvements from the other type.

SOILS.

Mr. M. F. Morgan in charge.

1. **Utilizations and Fertilizer Requirements of Important Soil Types of Connecticut.** Previous intensive studies of soil conditions and land utilization in Lebanon yielded data which was studied in relation to the economic survey conducted by the department of Rural Economics of the Connecticut Agricultural College. It was found that, in the above town, the area in which the Charlton series of soil occurred, was markedly superior as a dairy region to the other portions of the town where Gloucester fine sandy loam, Gloucester stony fine sandy loam and the Merrimac series were the principal soils. Interesting relationships of soils to land cover were also manifested.

These results having shown the necessity for further study in regions where somewhat different soil conditions occurred, the areas of Wilton, Goshen, Middletown, Pomfret, Eastford and Stonington were surveyed during the field season. The use of airplane photographs materially aided the study of land utilization and accurate mapping of soil type areas in the town of Middletown.

A lack of uniformity of soil conditions was found in the areas studied during the 1924 field season but certain soil types were shown to be fairly constant in their characteristics wherever found.

Land utilization studies as tabulated thus far bear out the fact that soils such as the Gloucester stony fine sandy loam, are of value chiefly for forestry and recreational sites, those similar to the Charlton loam are particularly adapted to dairying; while soils like the Merrimac sandy loam are peculiarly adapted to potatoes, intensive trucking and vegetable gardening.

The need for a thorough soil and land utilization survey becomes more and more apparent as the results of the present studies are considered.

Sub Project A—Soil Survey and Land Cover Studies of Selected Areas in Connecticut. This project has taken three phases of development: (1) Completion of maps and data incident to the soil-land cover and economic survey of Lebanon town, (2) Detailed land cover and soil type studies in the towns of Wilton, Goshen, Middletown, Pomfret, Eastford and Stonington, (3) Tabulation of data on these areas to show distribution of cover on the more important soil types.

Sub Project B—Pot Experiments on Effects of Fertilization of Important Soil Types. Pot experiments with 12 soil types of Connecticut, using alfalfa and buckwheat to show the effects of Lime, Nitrogen and Phosphorus, and these plus Potassium, show wide differences in fertility of untreated soils and in relative

responses to treatment. Sixteen samples of soil have been collected for further experiment.

Sub Project C—Soil Reaction Studies. Samples of various horizons of most of the soil types represented in each area studied in sub-project A have been collected for studies in lime requirement, *h-ion concentration*, and soluble aluminum compounds.

Sub Project D—Mechanical Analyses of Important Soil Types. Similar samples have been collected for this experiment in determination of mechanical analyses by U. S. Bureau of Soils and Harlan Jonson's method, and determination of colloidal material.

Sub Project E—Studies of Forest Adaptations of Important Soil Types. This experiment has two phases: (1) Identification of soil types on plots upon which forestry department made detailed studies of stands and associations, (2) Collections of seven soil types upon which studies are to be made of growth of seedlings of forest species in pot experiments.

Sub Project F—Chemical Analyses and Reaction Studies of Particular Pasture Soils. Soil samples have been collected from 25 pasture demonstration fields located in various parts of the state to determine the total Nitrogen, Phosphorus, Potassium, Calcium and Magnesium and the reaction of all samples.

TOBACCO SUB-STATION AT WINDSOR.

The sudden resignation of Mr. C. M. Slagg on March 1, made necessary a restriction of the Service work possible during the season of 1924. The experimental program, however, went forward without interruption. A very elaborate new project was launched, having as its object the improvement of the several types of Broadleaf and Havana now recognized among growers. A large number of so-called strains of each type were grown at Windsor and on plots scattered about the various type districts. These will be continued next year. Experiments under way may be listed:

1. Fertilizer Experiments
    a. Sources of Nitrogen.
    b. Ratio of Phosphoric Acid.
    c. Sources of Potash.
    d. Fractional Applications.
    e. Manure (New York and. cow (steer) compared with none).
    f. Magnesium, Chlorine and Sulfur. (U. S. D. A.).
2. Varietal Improvement
    a. Strain trials of Broadleaf, Havana and Cuban as a basis for future improvement.

b. Tests of crosses made by Dr. Jones.
c. Round tip cultural experiments to improve quality.
d. Trials for "foreign" or new types.
e. N. rustica as a source of nicotine.

3. Curing Experiments.
Lack of land for growing material prevented the carrying out of these as planned.

4. Diseases.
a. Tests of Control Measures for Wildfire.
b. Brown Root Rot (U. S. D. A.).
c. Black Root Rot, the effect of soil treatments.

Except as noted, the above program was carried out in spite of the fact that the position of superintendent was not filled. The weather was extremely dry and a partial crop failure resulted. At this time it is too early to estimate the results, the crop not being sorted.

A Field Day was held at the farm on August 5, about 400 persons attending. An excellent lunch was served by the ladies of a local church. A program for the day, held in the new shed, was a unique feature.

List of Publications Available for Distribution.

CROPS

150. Clover Seed in the Connecticut Market
180. Studies on the Tobacco Crop of Connecticut
191. Tests of Soy Beans, 1915
192. Observations on Alfalfa
193. Tests of Soy Beans, 1916
228. Connecticut Round-Tip Tobacco
259. Corn in Connecticut

FEEDING STUFFS

138. Commercial Feeding Stuffs in the Connecticut Market
141. Commercial Feeding Stuffs in the Connecticut Market
206. Report on Commercial Feeding Stuffs, for 1917
212. Report on Commercial Feeding Stuffs, for 1918
221. Report on Commercial Feeding Stuffs, for 1919
229. Report on Commercial Feeding Stuffs, for 1920
238. Report on Commercial Feeding Stuffs, for 1921
249. Report on Commercial Feeding Stuffs, for 1922
257. Report on Commercial Feeding Stuffs, for 1923

FERTILIZERS

156. Cotton Seed Meal As a Fertilizer
170. The Trade in Cotton Seed Meal
194. Manure from the Sea
198. Domestic Supplies of Potash
204. Report on Commercial Fertilizers, for 1917
209. Report on Commercial Fertilizers, for 1918
217. Report on Commercial Fertilizers, for 1919
223. Report on Commercial Fertilizers, for 1920
233. Report on Commercial Fertilizers, for 1921
241. Report on Commercial Fertilizers, for 1922
250. Report on Commercial Fertilizers, for 1923

FOOD AND DRUG PRODUCTS

200. Report on Food and Drug Products, for 1917
210. Report on Food and Drug Products, for 1918
219. Report on Food and Drug Products, for 1919
227. Report on Food and Drug Products, for 1920
236. Report on Food and Drug Products, for 1921
248. Report on Food and Drug Products, for 1922
255. Report on Food Products and Drugs, for 1923

FOODS

201. Food Fats and Oils
213. Condensed Milk, Malted Milk, Milk Powder
215. The Food Value of Milk
220. Report on Diabetic Foods
240. Commercial Vitamine Preparations

FORESTRY

231. Report of the Tree Protection Examining Board
253. Better Forests for Connecticut

INSECTS

155. The Elm Leaf Beetle
169. The Leopard Moth
177. The Apple Tree Tent Caterpillar
182. The Brown-Tail Moth
186. The Gypsy Moth
195. Insects Injuring Stored Food Products in Connecticut
203. Report of the Entomologist, for 1917
211. Report of the Entomologist, for 1918
218. Report of the Entomologist, for 1919
225. A Study of the Bulb Mite.
226. Report of the Entomologist, for 1920
230. The Grass-Feeding Frog-Hopper or Spittle-Bug
231. Report of the Tree Protection Examining Board
242. Report on Commercial Insecticides and Fungicides, 1922
245. Results of Dusting vs. Spraying in Connecticut Apple and Peach Orchards in 1922
246. The Apple and Thorn Skeletonizer
247. Report of the Entomologist, for 1922
251. The Raspberry Fruit Worm
252. The European Red Mite
256. Twenty-third Report of the State Entomologist (1923)
258. Report on Insecticides and Fungicides (1923)

PLANT DISEASES

214. Report of Botanist, for 1917 and 1918
222. New or Unusual Plant Injuries and Diseases Found in Connecticut 1916-1919
231. Report of the Tree Protection Examining Board
237. Control of the White Pine Blister Rust in Connecticut
239. Wildfire of Tobacco in Connecticut
242. Report on Commercial Insecticides and Fungicides, 1922
245. Results of Dusting vs. Spraying in Connecticut Apple and Peach Orchards in 1922
258. Report on Insecticides and Fungicides (1923)

POULTRY

202. An Experience in Keeping Poultry in the City

REPORTS OF DIRECTOR

232. Report of the Director for the Year Ending October 31, 1921
243. Report of the Director for the Year Ending October 31, 1922
254. Report of the Director for the Year Ending October 31, 1923
264. Report of the Director for the Year Ending October 31, 1924

REPORTS

Beginning with the year 1877 and ending with 1916 the Station issued Annual Reports. Of these the following are out of print: 1877-1880 inclusive, 1882, 1883, 1885, 1886, 1887, 1889-1892 inclusive, 1895-1906* inclusive.

Commencing with the year 1917, the annual reports include all regular bulletins; they are issued in parts and each part bears a bulletin number.

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*Of some other reports the Station has but a limited number, which are reserved to complete library sets.

BULLETIN 265 March, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

TWENTY-FOURTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

1924

W. E. BRITTON, Ph.D.
State Entomologist

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

March, 1925.

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Administration.	Wm. L. Slate, Jr., B.Sc., *Director and Treasurer.* Miss L. M. Brautlecht, *Bookkeeper and Librarian.* Miss J. V. Berger, *Stenographer and Bookkeeper.* Miss Mary Bradley, *Secretary.* William Veitch, *In Charge of Buildings and Grounds.*
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Biochemical Laboratory.	T. B. Osborne, Ph.D., Sc.D., *Chemist in Charge.*
Botany.	G. P. Clinton, Sc.D., *Botanist in Charge.* E. M. Stoddard, B.S., *Pomologist.* Miss Florence A. McCormick, Ph.D., *Pathologist.* Willis R. Hunt, M.S., *Graduate Assistant.* G. E. Graham, *General Assistant.* Mrs. W. W. Kelsey, *Secretary.*
Entomology.	W. E. Britton, Ph.D., *Entomologist in Charge; State Entomologist.* B. H. Walden, B.Agr.; M. P. Zappe, B.S.; Philip Garman, Ph.D. — *Assistant Entomologists.* Roger B. Friend, B.Sc., *Graduate Assistant.* John T. Ashworth, *Deputy in Charge of Gipsy Moth Work.* R. C. Botsford, *Deputy in Charge of Mosquito Elimination.* Miss Gladys M. Finley, *Stenographer.*
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Plant Breeding.	Donald F. Jones, S.D., *Geneticist in Charge.* P. C. Mangelsdorf, M.S., *Graduate Assistant.*
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Tobacco Sub-station at Windsor.	——————— *In Charge.* N. T. Nelson, Ph.D., *Plant Physiologist.*

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Authorship.

For bibliographical purposes, all matter in this Report (Bulletin 265) should be credited to W. E. Britton, except where otherwise indicated.

Illustrations.

The illustrations in this Bulletin are from the following sources: text figures are from drawings as follows: Fig. 7, map drawn by Alex. Cahn and shaded by Stoddard; Figs. 8-15, drawn by B. H. Walden. Plates are from photographs: Plate XXXVI, b, by R. B. Friend; XXX, b, by Dr. Philip Garman; XXXIII, b and c, by Nicholas Matiuck; XXIV, b, and XXV, a, by J. L. Rogers; XXXIII, a, and XXXIV, by R. C. Botsford; XVII, XVIII, b, XIX, XX, XXI, a, XXV, b, and XXIX, c, by W. E. Britton; XVIII, a, XXI, b, XXII, XXIII, XXIV, a, XXVI, XXVII, XXVIII, XXIX, a and b, XXX, a, b, c, d and e, XXXI, XXXII, XXXV, and XXXVI, a, by B. H. Walden.

BULLETIN 265

TWENTY-FOURTH REPORT

OF THE

State Entomologist of Connecticut

To the Director and Board of Control of the Connecticut Agricultural Experiment Station.

I have the honor to transmit, herewith, my twenty-fourth annual report as State Entomologist of Connecticut. As in preceding years, the report covers the activities of the Department of Entomology, as regards both the control and inspection work provided for by Statute, and the various lines of research which after all more properly represent the type of effort for which Agricultural Experiment Stations were established.

Respectfully submitted,

W. E. BRITTON,

State and Station Entomologist.

INSECT PEST ACCOUNT.

REPORT OF RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST

From July 1, 1923 to June 30, 1924.

RECEIPTS.

From W. L. Slate, Jr., Treasurer		$15,000.00	
Added to appropriation from miscellaneous receipts by State Board of Control		759.18	
Miscellaneous receipts during year	$82.55		
	117.79		
	400.30		
	30.92	631.56	
			$16,390.74
Less miscellaneous receipts deposited with State Treasurer during the year			600.64
			$15,790.10

EXPENDITURES.

For Salaries and Wages	$11,022.34	
Printing and Illustrations	79.23	
Postage	22.29	
Stationery	36.63	
Furniture and Fixtures	316.43	
Books and Periodicals (new)	61.61	
Books and Periodicals (binding)	128.25	
Laboratory Supplies	186.26	
Spraying Supplies	116.44	
Express, Freight and Cartage	20.67	

Automobiles: Insurance		$ 86.39	
Supplies and Equipment		97.95	
Repairs		173.36	
Gasoline		206.99	
Oil		10.55	
Traveling Expenses		482.03	
Miscellaneous		2.40	
Telephone and Telegraph		2.34	
Rental and Storage		2.50	
			$13,054.66
Balance on hand June 30, 1924	$2,704.52		
Miscellaneous receipts	30.92		2,735.44
			$15,790.10

Memorandum.—This account has been audited by the State Auditors of Public Accounts and the balance returned to the State Treasurer.

SUMMARY OF INSPECTION AND OFFICE WORK.

337 samples of insects received for identification.
122 nurseries inspected.
118 regular certificates granted.
5 special raspberry certificates granted.
116 duplicate certificates furnished to be filed in other states.
109 parcels of nursery stock inspected and certified.
953 bales of mountain laurel and willow (21 trips) inspected and certified for shipment into New York.
49 orchards and gardens examined.
33 shipments, containing 313 cases, 3,489,170 plants, imported nursery stock inspected.
17 shipments, or 51 per cent. found infested with insects or fungi.
953 apiaries, containing 8,929 colonies inspected.
17 apiaries and 47 colonies found infested with European foul brood.
10 apiaries and 20 colonies found infested with American foul brood.
2,265 letters written on official work.
456 circular letters.
591 post cards.
46 reports to Federal Horticultural Board.
2,303 bulletins, etc., mailed on request or to answer inquiries.
70 packages sent by mail or express.
38 lectures and addresses at institutes, granges and other meetings.

PUBLICATIONS OF THE ENTOMOLOGICAL DEPARTMENT, 1924.

BY W. E. BRITTON:

Twenty-third Report of the State Entomologist of Connecticut (Bulletin 256), 96 pages, 8 figures, 16 plates; 10,500 copies distributed in July.
Inspection of Nurseries in 1923, 8 pages, reprinted from the Report.
The Apple and Thorn Skeletonizer, Bulletin of Immediate Information 39, May 17.
Spraying Shade Trees, Bulletin of Immediate Information 40, May 20.
The Apple Maggot or Railroad Worm, Bulletin of Immediate Information 43, June 16.
The Gipsy Moth Quarantine, Bulletin of Immediate Information 44, 4 pages, July 15.
Report of Committee on Injurious Insects, Proceedings 33rd Annual Meeting Connecticut Pomological Society, page 41, 1924.

Some Insects to be Combatted Next Season, Proceedings 33rd Annual Meeting, Connecticut Pomological Society, page 72, 1924.
Insects Attacking Vegetable Crops in Connecticut in 1923, Report Connecticut Vegetable Growers' Association, page 43, April 1924.
An Asiatic Beetle (*Anomala orientalis*) in Connecticut, Journal of Economic Entomology, Vol. 17, page 309, April, 1924.
The Gipsy Moth and Our Forests, New England Farms, June 21, 1924.
Connecticut Tree Workers' Institute, Florists' Exchange, Vol. LVII, page 890, March 22, 1924.
Proceedings Shade Tree Conference, Florists' Exchange, Vol. LVIII, page 703, September 6, 1924 (also a four-page reprint).
Some Insect Information from a Connecticut Conference, Florists' Exchange, Vol. LVIII, Supplement Page A, November 29, 1924.
Meeting of Connecticut Entomologists, Journal of Economic Entomology, Vol. 17, page 669, December, 1924.

y W. E. Britton, Philip Garman, G. P. Clinton and E. M. Stoddard:
Information about Insecticides and Fungicides, Bulletin of Immediate Information 30, March 26.
Why and How to Spray, Bulletin of Immediate Information 31, March 28.

y W. E. Britton and Philip Garman:
Dormant Sprays for Orchard Pests, Bulletin of Immediate Information 29, March 22.

y W. E. Britton, G. P. Clinton and W. O. Filley:
Tree Workers Holding Connecticut Certificates, Bulletin of Immediate Information 35, 4 pages, April 25.

y W. E. Britton and R. C. Botsford:
Mosquitoes and Human Welfare by W. E. Britton, and Mosquito Control Work, Season of 1923 by R. C. Botsford, 16 pages, 2 plates (1,000 copies reprinted from Report), June 24.

y Philip Garman:
The European Red Mite, Bulletin 252, 25 pages, 2 figures, 2 charts, 4 plates; 10,600 copies, February 1924.
Control of European Red Mite in Connecticut, Proceedings, 33rd Annual Meeting, Connecticut Pomological Society, page 44, 1924.
The Oriental Peach Moth, Bulletin of Immediate Information 41, May 20.
Factors Influencing the Effectiveness of Arsenate of Lead, Florists' Exchange, Vol. LVIII, page 685, September 6.

y B. H. Walden:
The Raspberry Fruit Worm, Bulletin 251, 11 pages, 1 figure, 4 plates; 10,600 copies, February 1924.
The Raspberry Fruit Worm, Proceedings, 33rd Annual Meeting, Connecticut Pomological Society, page 124, 1924.
Spray for the Imported Currant Worm, Bulletin of Inmediate Information 34, April 21.

y M. P. Zappe and E. M. Stoddard:
Results of Dusting *versus* Spraying in Connecticut Apple and Peach Orchards in 1922, Crop Protection Digest, Bulletin Series No. 4, page 2, June 1924.
The Calyx and Later Summer Sprays, Bulletin of Immediate Information 36, May 1.
Peach Spraying, Bulletin of Immediate Information 37, May 3.
Progress of Spraying and Dusting Experiments, Proceedings 33rd Annual Meeting Connecticut Pomological Society, page 52, 1924.

BY M. P. ZAPPE AND G. P. CLINTON:
The Prepink and Pink Sprays for Apples, Bulletin of Immediate Information 33, April 15.

BY R. C. BOTSFORD:
Accomplishments in the Past Year in Anti-Mosquito Work in Connecticut, Proceedings 11th Annual Meeting of the New Jersey Mosquito Extermination Association, page 80, 1924.

DEPARTMENT STAFF AND WORK.

W. E. BRITTON, PH.D., *State and Station Entomologist.*
B. H. WALDEN, B.AGR., *Photographic and General Work.* } *Assistant Entomologists.*
M. P. ZAPPE, B.S., *Inspection and General Work.* } *Assistant Entomologists.*
PHILIP GARMAN, PH.D., *Research Work.* } *Assistant Entomologists.*
ROGER B. FRIEND, B. SC., *Graduate Research Assistant.*
JOHN T. ASHWORTH, *Deputy in Charge of Gipsy Moth Work.*
JAMES A. MCEVOY, *Assistant in Gipsy Moth Work.*
ROBERT C. BOTSFORD, *Deputy in Charge of Mosquito Work.*
MISS GLADYS M. FINLEY, *Clerk and Stenographer.*

H. W. COLEY, Westport, } *Apiary Inspectors.*
A. W. YATES, Hartford, } *Apiary Inspectors.*

The only change in the staff during the year was the appointment of Mr. Roger B. Friend, who began his duties January 1, 1924, as part time assistant. Mr. Friend graduated from the Massachusetts Agricultural College in 1923, and was employed for the remainder of that year by the Conservation Commission of New York State, on gipsy moth work. Mr. Friend is studying at Yale University for his doctorate, and is employed at the Station during the time when not busy with his studies. He is investigating the bionomics of the birch leaf skeletonizer and has also given considerable attention to control methods of certain insects attacking vegetable crops. Articles occur elsewhere in this Report giving the results of Mr. Friend's work on Substances Attractive to the Cabbage Maggot Fly, and Experiences in Dusting to Kill the Pea Aphid, Cabbage Aphid and Onion Thrips.

Mr. J. Leslie Rogers was employed as assistant from February 25 until the end of the year. He was engaged until the nurseries had been inspected, then was continued to help in scouting for the European corn borer. Mr. T. F. Cronin was also employed to assist in inspecting nurseries, working from June 23 until September 15, when he returned to his studies at the Connecticut Agricultural College at Storrs. Mr. W. R. Hunt, graduate assistant in the Botanical Department of this Station, was placed on the pay roll of this Department for the three months from July 1 until October 1, and assisted in the inspection of nurseries, paying particular attention to plant diseases.

Mr. Walden has done most of the photographic work of the Department, has had charge of the office in the absence of the Entomologist, and has assisted in scoring apples in the dusting and spraying experiments. He has also conducted some research work on the imported currant worm, *Pteronidea ribesi* Scop.

Mr. Zappe has been in charge of the inspection of nursery stock, and of scouting and clean-up work on account of the European corn borer in co-operation with the Federal Bureau of Entomology. He and Dr. Garman have investigated the life history and control of the Asiatic beetle, and the plum curculio as a pest of apple orchards. In co-operation with Mr. Stoddard of the Botanical Department, he has made further tests of various dusts in comparison with sprays for the control of various insect and fungous pests of apple orchards.

Dr. Garman has conducted investigations regarding methods of control for the Oriental peach moth, the American foul brood disease of bees, has continued his studies on life histories and habits of spittle insects, the European red mite, and, as noted above, jointly with Mr. Zappe, has investigated the plum curculio, and the Asiatic beetle. Dr. Garman has also constantly revised his manuscript on the Odonata or dragon flies of Connecticut, which is now ready and will sometime be published as a bulletin of the State Geological and Natural History Survey.

Mr. Botsford has continued to serve as Deputy to Director W. L. Slate in charge of mosquito elimination work, and Miss Finley has done the necessary clerical and stenographic work of the Department.

The gipsy moth control work has been prosecuted vigorously as in past years, the field work being entirely in charge of Deputy John T. Ashworth, assisted by James A. McEvoy. This work is carried on in co-operation with the Federal Bureau of Entomology and is fully described in this Report.

The apiaries have been inspected as in past years by Messrs. H. W. Coley and A. W. Yates, on a *per diem* basis.

The Entomologist, besides directing the work of the Department and attending to the correspondence of the office, has continued to serve as Associate Editor of the Journal of Economic Entomology, as Chairman of the Tree Protection Examining Board, and as Insect Pest Reporter for the Insect Pest Survey of the Federal Bureau of Entomology. He has in preparation a list of additions and corrections to the Check List of the Insects of Connecticut, which it is hoped can be published at an early date by the State Geological and Natural History Survey.

Messrs. Britton and Walden are collaborators of the Federal Horticultural Board, and Zappe, Garman, Friend and Ashworth are collaborators of the Bureau of Entomology.

In July, a new Chevrolet touring car was purchased and was used nearly all of the time for transporting the men while engaged in the work of inspecting nurseries.

The more important activities of the Department are described in the various papers in the following pages of this Report.

ENTOMOLOGICAL FEATURES OF 1924.

The season of 1924, like that of 1923, was abnormal and began with cool moist weather followed by a drought. Very little rain fell between July 1 and October 1, and the drought of 1924 was even more severe than that of 1923.

Some of the outstanding features of the season were the disappearance in injurious numbers of the apple and thorn skeletonizer, which was so abundant in 1923, the greater increase in the Oriental peach moth, and further infestations of the European corn borer in six towns along the coast.

There has been no serious spread of the gipsy moth, though a few additional towns were found infested by the Federal scouts. Because it was not possible for the Federal men to scout the entire southern portions of New Haven and Middlesex Counties and it was not known whether or not they were infested, some 23 additional towns were included in the quarantined area.

Though a watch has been kept, not a single nest of the browntail moth has been seen in Connecticut since 1919.

Fruit Insects.

The tent caterpillar, *Malacosoma americana* Fabr., continued to be abundant throughout the State, though particularly so in the western portion. Every 10 or 12 years this insect reaches its period of greatest abundance, being comparatively scarce half way between these high periods, probably checked by natural enemies.

The fall canker worm, *Alsophila pometaria* Harris, which is present locally somewhere in the State nearly every year was very abundant in Greenwich and Stamford in early summer and stripped many kinds of deciduous trees, apple, elm, hickory and oak being particularly injured. A few caterpillars were found feeding on maple, but the trees were not stripped. Around New Haven, this insect was present in destructive numbers, but no injury was observed or reports of injury received from outside of New Haven and Fairfield Counties. See Plate XXXII.

The apple and thorn skeletonizer, *Hemerophila pariana* Clerck, which was so prominent and was responsible for so many brown apple trees in 1923, was conspicuous by its absence in 1924. Evidences of its presence could be found in nearly every orchard by the slight skeletonization on terminal leaves, but its work had been arrested, the caterpillars were not there and no particular damage had been done. Apparently natural enemies have been unusually prompt in subduing this insect.

On the other hand, the Oriental peach moth, *Laspeyresia molesta* Busck, was much more in evidence than in 1923, and wormy peaches were rather common in Fairfield and New Haven Counties, late in the season. If this pest continues to spread, its control will

become one of our most important problems. Further details will be found elsewhere in this Report.

The European red mite, *Paratetranychus pilosus* Can. and Fanz., was less abundant in 1924 than in 1923, and no serious injury from its attacks was brought to my attention. Eggs were present in winter in many orchards, especially in the northern portion of the State, but spraying the dormant trees with miscible oils was generally practiced with satisfactory results. Probably the wet spring may have reduced the numbers of this pest, for it was not evident later in the season in most orchards, and I have yet to learn of a single case where it was considered necessary to give a summer spray in 1924 for its control.

The sinuate pear borer, *Agrilus sinuatus* Oliv., continues to spread eastward and it causes some injury at first. This European insect first appeared in the United States in New Jersey some 20 years ago, caused serious injury there for a few years, but is now not regarded as a serious pest. It was first recognized in Connecticut in 1917 at Norwalk, and the writer observed its destructive work in a pear orchard in Stamford in 1920. In May 1924, after the receipt of specimens, Mr. Zappe visited the premises of Mr. W. T. Camp, Shelton, where several old trees had been nearly killed by this insect, and had been removed. Other pear trees in the vicinity had been more or less injured. Probably the best treatment consists in removing and burning the seriously injured trees and branches; then cut out the borers from the remaining portion and coat the bark with a wash of lime-sulphur and lead arsenate to repel the beetles and possibly kill the larvae when they enter the bark. The foliage should also be kept covered with lead arsenate during May and June to kill the adult beetles which feed there before laying eggs. If the trees are kept well fertilized and cultivated, they will be more apt to outgrow injury caused by this insect.

Males of the lime tree winter moth, *Erannis tiliaria* Harris, were fairly abundant flying about lights in the fall, and the greenish-yellow black-spotted females were found on tree trunks. The caterpillars feed upon apple trees and on elm, linden and other trees in the woodlands. The caterpillars feed at about the same time as canker worms, but are larger and there is danger that they will cause some damage the coming season. Spraying with lead arsenate is the remedy. Further information will be found on page 311 of this Report.

The light or false apple red bug, *Lygidea mendax* Reut., was rather less abundant than usual, though it caused some injury locally here and there. Fruit injured by it in Wallingford and Danbury was brought to our attention.

The rosy apple aphis, *Anuraphis roseus* Baker, was rather scarce in most orchards early in the season, though egg-infested twigs were received in March from Middlebury, Middlefield, Milford,

Cannondale and South Glastonbury. On June 9 it was observed in Stamford and Wallingford. By June 24, it was present in moderate numbers in nearly every orchard and injury was caused by it in some cases.

The green apple aphid, *Aphis pomi* DeGeer, hatched in April, and on the 25th at Milford there was an average of about one aphid per bud, but on May 22, practically all aphids had disappeared in the orchards under observation in Milford, New Haven, Hamden and Cheshire.

The woolly apple aphid, *Eriosoma lanigerum* Hausm., seems to be present in nearly every orchard though it is uncertain just how much injury is caused by it. Further information regarding this insect may be found on page 308 of this Report.

The pear psylla, *Psylla pyricola* Foerster, was abundant on pear trees in Wallingford, Southington, Hebron and other places, though in one garden it was less common then for several years. It can be controlled by dormant sprays of nicotine solution and soap, of lime-sulphur and of miscible oils. Sometimes it may be necessary to give a summer treatment either as a spray or dust to prevent blackening of the fruit by later broods.

Leafhoppers were abundant on apple foliage, May 22, in Milford, Hamden and Cheshire.

The plum curculio, *Conotrachelus nenuphar* Herbst, yet remains one of the important pests of the apple orchard and series of experiments have given results which though somewhat contradictory, seem to indicate that thorough applications of lead arsenate at the pink, calyx and two weeks spray, will give fair control. Scarcely any additional benefit could be seen from the seven day treatment. Dr. Garman and Mr. Zappe have already worked two seasons on the five-year program for the study and control of this insect in apple orchards.

The currant aphid, *Myzus ribis* Linn., was present as usual on currant bushes, and specimens were received from Hebron on May 9, and from Colchester on May 16.

A particularly striking case of injured currant twigs attacked by the currant stem girdler, *Janus integer* Nort., was brought to the Station from Woodbridge in April.

Vegetable Insects.

Most of the common insect pests of the vegetable garden were present in 1924, but on account of the backwardness of the season, appeared two or three weeks later than usual. The absence of rain during July, August and September was favorable to some kinds of insect life and unfavorable to plant growth.

The usual amount of injury was caused by cutworms. During June, reports were received of injury to nearly all kinds of vegetable plants in New Haven County, but probably such injuries were not confined to one county but occurred all over the State. A more

general use of poisoned bran mash would certainly reduce the losses occasioned annually by cutworms.

The stalk borer, *Papaipema nitela* Guen., as a pest is fairly constant each year, and tunnels in nearly all kinds of herbaceous stems, even in weeds. It attacks plants here and there, but never are all stems attacked. Growers pay little attention to it, until the stems have been injured. Control measures other than destroying the infested stalks are not successful. Probably on account of the wide distribution of this insect and the character of the injury which it causes, few reports come to this office. However, specimens were received in potato from Terryville, August 7, and in rhubarb from Wethersfield, August 12.

The cucumber or potato flea beetle, *Epitrix cucumeris* Harris, is usually a garden pest each year, and in 1924, was abundant in many fields attacking potato, tomato, egg-plant, cucumber and squash. Reports were received of the abundance of this insect at Woodstock, Brooklyn, Killingly, Cheshire, North Haven, Southington, Plainville and Stratford in June. In the potato field at the Station Farm, Mount Carmel, the beetles were very abundant on the untreated rows, moderately abundant on the rows treated with Niagara potato dust, and much less so on the rows heavily sprayed with Bordeaux mixture and lead arsenate. About 300 gallons per acre was applied on August 2.

On July 18, specimens were received from Shelton of the silver-striped webworm, *Crambus praefectellus* Zinck., which eats into the side of the corn plant near the surface of the ground. Occasionally this insect is the cause of considerable injury, and in 1919, an acre field of corn in New Haven was destroyed by it.

Only limited numbers of the corn ear worm, *Chloridea obsoleta* Fabr., were present on the ears of late maturing corn. Specimens were received on October 17, from Milford, where in one field about five per cent. of the ears were injured. On the whole, this insect did little damage.

The western corn root worm, *Diabrotica longicornis* Say, is present in Connecticut, where it was found in Granby feeding on the petals of flowers. More information regarding this insect may be found under Notes on Miscellaneous Insects in this Report.

One of the tortoise beetles, *Deloyala clavata* Fabr., feeding on potato, was received from Norwalk, July 25. Only rarely are these beetles sufficiently abundant to cause injury, and lead arsenate is an effective remedy, as it is also on foliage for the blister beetles, of which there are several species.

The spinach leaf-miner, *Pegomyia hyoscyami* Panzer, was present around New Haven, Stratford and Westport, in moderate numbers, but Mr. Friend failed to find a badly infested field suitable for a line of experiments which had been planned.

The cabbage maggot, *Hylemyia brassicae* Bouche, was scarce in Litchfield County, but was reported as causing much injury in New

Haven, Hamden, Vernon, Hebron and Ellington late in June. By June 26, it had attacked cabbage and cauliflower in Ridgefield, Bethel and Danbury. Common control measures are tarred paper disks, and the corrosive sublimate treatment, but Mr. Friend obtained good control by trapping the adult flies. His experiments are given in detail on page 314 of this Report.

The green cabbage worm, *Pontia rapae* Linn., though fairly abundant at the Station Farm, Mount Carmel, was generally scarce and caused little damage. In most cases no poison was applied. The cabbage looper, *Autographa brassicae* Riley, was more prevalent than the green cabbage worm, and injured the leaves and heads by riddling them with holes.

Another pest, the parsnip leaf-miner, *Acidia fratria* Loew, was discovered in Wethersfield, July 12. The infestation was slight though the mines were rather extensive in the leaves. The species has before been taken in Connecticut, but we have never observed its injury until 1924. The life history and control measures have not been worked out, and therefore we cannot recommend any treatment.

The onion thrips, *Thrips tabaci* Linde., was found injuring a field of onion sets at Wethersfield. The plants had not been wilted, and on July 16 and 21, nicotine was applied as described on another page of this Report.

Asparagus beetles, *Crioceris asparagi* Linn., and *C. 12-punctata* Linn., were reported as being troublesome at Suffield, June 9; Black Hall, June 18; Riverton, June 24, and Danbury and Norwalk, June 26. As a rule, spraying with lead arsenate after the cutting season is over, and on young beds will control these beetles. Some growers report success with applications of nicotine sulphate.

Aphids of certain kinds were present in usual numbers and caused the usual amount of damage. On August 6, the turnip aphid, *Aphis pseudobrassicae* Davis, was brought to the Station from East Haven, where it had killed and seriously injured turnip plants in a small field. The pea aphid, *Illinoia pisi* Kalt., was not generally troublesome, though it did injure certain fields, and made its appearance very late in the season. It was reported from Thomaston and Danbury on June 24, and a heavy infestation at Ridgefield on June 26. A small field in New Haven was found infested on June 19, and a few days later a small portion of it was dusted with nicotine by Messrs. Friend and Walden. The results are given on page 319 of this Report. The potato aphid, *Macrosiphum solanifolii* Ashm., was rather scarce and only one thoroughly infested field in Branford, was observed on July 1, but the aphids were heavily parasitized. Slight infestations were observed in Westville and Highwood on June 30, but there was no infestation of the potato fields at the Station Farm at Mount Carmel. The cabbage aphid, *Brevicoryne brassicae* Linn., was common through-

out the State, but repeated applications of nicotine dust gave satisfactory control.

A detailed account of the European corn borer infestations and the Asiatic beetle which is still injuring lawns in New Haven will be found on pages 277 and 294 of this Report.

Shade Tree and Forest Insects.

The great abundance of the tent caterpillar, *Malacosoma americana* Fabr., and of the fall canker worm, *Alsophila pometaria* Harris, in southwestern Connecticut, as well as the lime tree winter moth, have already been mentioned under Fruit Insects. They are also pests of shade and woodland trees, and might be included here with equal appropriateness. The gipsy moth also is a pest of both fruit and shade trees, but is discussed separately on page 254 of this Report.

The fall webworm, *Hyphantria cunea* Dru., was less abundant than in 1923, except in New London County, where it was about as abundant.

The elm leaf beetle, *Galerucella xanthomelaena* Schrank (*luteola* Mull.) was a contributing cause to many brown and leafless elm trees in certain localities in central and southwestern Connecticut in August. Even some trees which had been sprayed with lead arsenate presented a pitiable condition. Of course the extreme drought aggravated this condition and new growth did not follow quickly as is the case in a moist season. All choice trees should be sprayed very carefully the coming season to prevent defoliation, as three successive and complete defoliations will usually kill a tree.

The oak leaf-roller, *Tortrix quercifoliana* Fitch, was particularly conspicuous around Stamford, where certain pin oaks were nearly defoliated, as is described on page 336.

Woolly aphids on conifers were particularly abundant in 1924, perhaps the most noticeable being the larch leaf aphid, *Chermes strobilobius* Kalt., and the one attacking Douglas fir, which is probably *Chermes cooleyi* var. *coweni* Gill. The latter was unusually common, was sent to the Station several times, and the members of the staff observed it widely. Spraying with nicotine solution and soap is a remedy.

The arbor vitae leaf-miner, *Argyresthia thuiella* Pack., was not particularly injurious in 1924, yet some of its work could be seen here and there about the State. Twigs received from Pomfret, July 5, had the leaves partially mined by this insect.

The larch leaf-miner or case bearer, *Coleophora laricella* Hubn., was somewhat in evidence, though not so destructive as in 1923.

The leopard moth, *Zeuzera pyrina* Linn., though not so destructive to trees along the coast as a few years ago, has spread inland and is the cause of considerable injury. The writer saw in Hartford during the winter many branches which had broken

from the trees on account of having been weakened by the larg burrows of the larvae of this insect. Material has also bee received from New Haven and Highwood during the season.

Sawfly larvae were rather more abundant than usual on pines causing some defoliation.

The birch leaf skeletonizer, *Bucculatrix canadensisella* Chambers was generally less abundant than in 1923, but there were portion of the State where locally the gray birches were brown in September.

One event of the season was the recognition of a European saw fly, *Fenusa pumila* Klug.,which has apparently become established in this country and which is a leaf-miner on the terminal leaves o gray birch.

Evidence was also obtained to show that the European pine shoot moth, *Evetria buoliana* Schiff., occurs in Connecticut.

The bronze birch borer, *Agrilus anxius* Gory, continues to kil European cut-leaf white birches throughout the State.

The juniper webworm, *Dichomeris* (*Ypsolophus*) *marginellus* Fabr., was received from New Canaan, June 19.

Miscellaneous Insects.

The European fly, *Muscina pascuorum* Meigen, which appeared in New England in 1922*, and which was rather abundant in Connecticut in 1923, was not seen at all around the Station laboratory in 1924. Plans were made for Mr. Friend to work out the life history of this fly, but as no material could be obtained, the plans were suspended.

Another instance was brought to our attention of a nuisance caused by the presence in greenhouses at Rowayton, of large number of the tropical cockroach, *Pycnoscelus surinamensis* Linn. (See Notes on Miscellaneous Insects.)

The biting dog louse, *Trichodectes latus* Nitzsch, (order Mallophaga) was received from Pomfret, this being the first record of the species in Connecticut.

Defoliation of honeysuckle shrubs and vines was caused by sawflies, *Abia americana* Cress., and of Rudbeckia, "golden glow", by some other species of sawfly which has not yet been identified with certainty.

Ants were very abundant everywhere during 1924, and many complaints were received of ants in houses, of ants injuring vegetable and flowering plants in gardens, and of ants infesting lawns. In each case a copy of Bulletin of Immediate Information No. 17, "Control of Ant Invasions", was sent and in several instances the Federal formula for poison bait given on page 4, was used with success.

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* **Report of this Station for 1922, page 373.**

Convention of Entomological Workers.

As there are now several entomologists employed at this Station, and several field foremen on gipsy moth work, several Federal men in the State on gipsy moth and European corn borer control, teachers of entomology in Yale University and the Connecticut Agricultural College, and several amateur entomologists, it was thought desirable to bring them all together for a conference. Consequently they were invited to meet at the Station on October 31, 1924. Dr. Britton was elected Chairman of the meeting and additional talks were given by Mr. D. J. Caffrey, a former Assistant at the Station, now in charge of the Federal European Corn Borer Laboratory, Arlington, Mass., and by Mr. S. S. Crossman of the Federal Parasite Laboratory, Melrose Highlands, Mass., who has made several trips to Europe in search of gipsy moth parasites. The following program was arranged and carried out, not a single speaker being absent.

PROGRAM.

A.M.		
10.00	Words of Welcome,	W. L. Slate, Jr., New Haven
10.05	Entomological Work of the Station,	W. E. Britton, New Haven
10.15	Some Animal Parasites,	G. H. Lamson, Jr., Storrs
10.30	The Asiatic Beetle in Connecticut,	M. P. Zappe, New Haven
10.45	Teaching Entomology in Connecticut Institutions:	
	Connecticut Agricultural College,	J. A. Manter, Storrs
	Yale University Undergraduates,	A. Petrunkevitch, New Haven
	Yale University School of Forestry,	W. R. Coe, New Haven
11.30	Opportunities for Beekeeping in Conn.,	L. B. Crandall, Storrs
12.00	Oriental Peach Moth in Conn.,	Philip Garman, New Haven
12.30	Luncheon.	
P.M.		
1.45	Some Baits Attractive to Cabbage Maggot Flies,	R. B. Friend, New Haven.
2.00	Hints on Photographing Insects,	B. H. Walden, New Haven
2.15	Gipsy Moth Work in Connecticut in 1924,	J. T. Ashworth, Danielson
2.45	Status of the Gipsy Moth in the United States,	A. F. Burgess, Melrose Highlands, Mass.
3.30	The European Corn Borer in the United States,	L. H. Worthley, Arlington, Mass.
4.15	Anti-Mosquito Work in Connecticut in 1924,	R. C. Botsford, New Haven

Messrs. Zappe, Friend, Walden, Garman and Botsford illustrated their talks by lantern slides.

There were a number of opinions expressed, all to the effect that the meeting had been a success and a hope that other meetings may be held in the future. About 60 were present as follows: Mr. and Mrs. A. F. Burgess, A. F. Burgess, Jr., C. W. Collins, H. L. Blaisdell, S. S. Crossman, Melrose Highlands, Mass.; L. H. Worthley, D. J. Caffery, R. A. Vickery, T. M. Cannon, Arlington, Mass.; Mr. and Mrs. Albert Hartzell, Yonkers, N. Y.; H. C. Huckett, Riverhead, N. Y.; H. J. Evans, Mineola, N. Y.; D. G. Murphy, Pittsfield, Mass.; H. A. Ames, Bound Brook, N. J.; Professors Alexander Petrunkevitch and W. R. Coe, Yale University, New Haven, Conn.; Professors G. H. Lamson, Jr., J. A. Manter, L. B. Crandall, A. J. Grady, T. F. Cronin, V. A. Johnson, J. W. Balock, Storrs, Conn.;

F. C. Rich, Ansonia, Conn.; W. A. Collins, New Milford, Conn.; J. J. Pillsbury, Burnside, Conn.; Professor Pauline H. Dederer, Connecticut College for Women, New London, Conn.; S. E. May, Canaan, Conn.; P. H. Meagher, Wallingford, Conn.; John T. Ashworth, J. W. Longo, A. J. Gilbert, H. A. Woodmancy, H. E. Cook, O. B. Cooke, C. M. Spencer, Danielson, Conn.; Dolor LaBelle, Ballouville, Conn.; James A. McEvoy, Putnam, Conn.; A. W. Yates, Hartford, Conn.; H. W. Coley, Westport, Conn.; E. J. Smith, Clintonville, Conn.; Mr. and Mrs. Henry S. Woolley, Waterbury, Conn.; P. L. Buttrick, New Haven, Conn.; Robert E. O'Brien, New Haven, Conn.; and Messrs W. L. Slate, Jr., E. H. Jenkins, G. P. Clinton, E. M. Stoddard, G. E. Graham, Philip Garman, M. P. Zappe, B. H. Walden, R. C. Botsford, R. B. Friend, Leslie Rogers and W. E. Britton of the Agricultural Experiment Station, New Haven, Conn.

INSPECTION OF NURSERIES IN 1924.

The annual inspection of growing nursery stock was begun July 25, and was finished October 14, except for one plantation inspected December 30. This work was in charge of Mr. M. P. Zappe, and was conducted about the same as in 1923, except that Mr. W. R. Hunt of the Botany Department assisted and was present during the inspection of all the larger nurseries. Consequently more attention could be given to plant diseases than heretofore. The work was done by Messrs. Zappe, Friend, Hunt, Cronin and Rogers. Mr. Ahearn inspected one strawberry nursery and Dr. Britton helped inspect two nurseries. Two nurseries were inspected in the spring and again at the time of the annual inspection.

In addition to the inspections made from this office, the gipsy moth scouts were instructed to make careful inspections for gipsy moth eggs in and around nurseries, and to have it reported to the office in case any were found.

In 33 nurseries, no important pests were found. Following is a list of insects and plant diseases found in nurseries, together with the number of nurseries infested by each, as taken from the inspection reports on file in the office:

List of Pests Found in Nurseries in 1924

Nurseries uninfested 33

INSECTS

Aphids, apple, green	7	Curculio, poplar	1
woolly	5	Elm leaf beetle	1
pine bark	3	Fall webworm	4
spruce gall,		Lace bugs, on rhododendron	3
Chermes abietis	40	Leopard moth larva	1
cooleyi	12	*Laspeyresia molesta*	6
Apple and thorn skeletonizer	2	Leaf hoppers, on apple	4
Birch Bucculatrix	4	Mite, European red	2
Birch leaf-miner	1	pear blister	4
Borer, lilac	2	*Papaipema* larva	1
locust	1	Red humped caterpillar	2
poplar	1	Sawfly, *Diprion simile*	2

INSECTS—*concluded.*

Sawfly, larch	1	Scale, San José	32
Scale, elm	8	scurfy	2
euonymus	1	tulip tree	6
lecanium	1	West Indian peach	1
oak	1	white elm	1
oak gall scale (*Kermes*)	1	on *Juglans*	1
oyster-shell	44	White pine weevil	5
pine leaf	5	White grub in seed beds (*Abies*)	1
rose	6	White grub in Multiflora roses	1

PLANT DISEASES

Apple scab	12	Mildew on cherry	1
Black knot	1	cornus	1
Brown rot	4	grapes	6
Canker on apricot	1	lilac	2
horsechestnut	1	peaches	1
nectria	2	roses	15
poplar	25	snowdrop	1
sycamore	1	Mosaic, raspberry	8
Crown gall	3	Rust on ash	1
Fire blight	1	blackberry	1
Leaf spot on roses	2	white pine blister, (on Ribes)	8
Mildew on apples	5		
catalpa	3	cedar (on apple)	15

From the preceding list it may be seen that the oyster-shell scale is still the commonest pest found in Connecticut nurseries, and was found in 44 different nurseries. The next commonest is the spruce gall aphid, 40 nurseries. Next in order is the San José scale, 32 nurseries. Following these comes a fungus, the poplar canker, 25 nurseries.

In order to show how the figures of 1924 correspond with those obtained in preceding years, the following table gives the figures as reported by the inspectors for the past seven years.

SEVEN YEAR RECORD OF SERIOUS AND COMMON NURSERY PESTS.

Pest	1918	1919	1920	1921	1922	1923	1924
Oyster-shell scale	39	38	38	36	44	42	44
San José scale	18	19	11	28	19	20	32
Spruce gall aphid	15	19	21	31	21	28	40
White pine weevil	5	5	1	1	19	17	5
Apple and thorn skeletonizer	..	..	..	..	1	18	2
Poplar canker	6	5	13	21	31	34	25
Blister rust (on Ribes)	1	..	..	2	9	6	8
No pests	32	32	46	36	36	32	33

It may be seen from the figures given in the table above that the oyster-shell scale (44) is, and has been for the past seven years, the most common pest found in nurseries. In 1924, the pests which were the next commonest are the spruce gall aphid (40), the San José scale (32), and the poplar canker (25). Then follows the pine blister rust which was found in eight nurseries, in all cases on the leaves of *Ribes*. The apple and thorn skeleton-

izer was found in two nurseries in 1924 as against 18 nurseries in 1923. Brief accounts of three of these major pests were given in the Report of this Station for 1923 (Bulletin 256), page 240.

Number of Nurseries.

During the year, 122 regular nurseries have been inspected, and 118 certificates granted. Since last year, eight nurseries have gone out of business, three have changed firm names, and 18 new nurseries have been started. Two nurseries were inspected in the spring and certificates issued, and again examined and certificated at the time of the regular inspection. Besides these inspections, 109 separate parcels of nursery stock were inspected and certificates furnished; also 116 duplicate certificates were furnished for filing in other States.

The total area of Connecticut nurseries in 1924 is 1,779 acres, and the nurserymen's list contains 116 names, as follows:

Nursery Firms in Connecticut Receiving Certificates in 1924

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Barnes Bros. Nursery Co.	Yalesville	150	Aug. 30	1490
Barnes Nursery & Orchard Co.	Wallingford	45	Oct. 1	1519
Barton Nursery	Hamden	1	Oct. 9	1541
Beattie, Wm. H.	New Haven	1	Oct. 2	1527
Benbow, A.	Norfolk	1	Oct. 15	1547
Berkshire Nurseries (C. B. Myers, Prop.)	Milford	6	Oct. 23	1553
Bertolf Brothers	Greenwich	25	Sept. 17	1508
Brainard Nursery & Seed Co.	Thompsonville	10	Sept. 13	1502
Braley & Co.	Burnside	1	Aug. 28	1487
Bretschneider, A.	Danielson	1	Sept. 10	1498
Bristol Nurseries, Inc	Bristol	16	Oct. 7	1539
Burr & Co., C. R.	Manchester, Ellington and Durham	500	Aug. 20	1476
Burroughs, Thos. E.	Deep River	3	Sept. 2	1491
Chapman, C. B.	Groton	1	Sept. 12	1499
Chapman, C. E.	No. Stonington	2	Sept. 18	1509
Clinton Nurseries (Warren Richards, Mgr.)	Clinton	1	Oct. 8	1540
Coari, Louis (2)	Southport	6	Sept. 30	1518
Conine Nursery Co	Stratford	50	Sept. 12	1501
Conn. Agricultural College (Prof. S. P. Hollister)	Storrs	1	Aug. 19	1473
Conn. Agr. Exp. Sta. (W. O. Filley, Forester)	New Haven	2	Oct. 6	1536
Crofut & Knapp Farm	Norwalk	20	Dec. 31	1583
Cross Highway Nurseries	Westport	6	Dec. 31	1580
Dallas, Inc., Alexander	Waterbury	1	Nov. 13	1563
Dawson's Nursery	Willimantic	2	Sept. 20	1511
De Wyn, Peter	Yalesville	1	Aug. 22	1481
Dowd, Inc., F. C.	Madison	1	Sept. 3	1493
Dunlap, Daniel S.	Cromwell	1	Sept. 16	1504
East Rock Nursery (J. Palmeri, Prop.)	New Haven	1	Oct. 6	1535

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1924—*Con.*

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Edgewood Nursery, Vidal, Inc.	Stamford	5	Nov. 5	1560
Eells, Wm. W.	Manchester	1	Sept. 9	1497
Elm City Nursery Co., Woodmont Nurseries, Inc.	Woodmont and New Haven	155	Sept. 6	1495
Evergreen Nursery Co.	Wilton	10	Aug. 27	1482
Fairty, C. H.	New Canaan	1	Dec. 1	1572
Fraser, G. W.	Willimantic	1	Aug. 19	1474
Gardner's Nurseries	Rocky Hill	8	Sept. 16	1506
Geduldig's Greenhouses	Norwich	1	Sept. 27	1514
Glenn Terrace Ornamental Nursery (James H. Everett, Prop.)	Mount Carmel	10	Dec. 1	1573
Heath & Co.	Manchester	5	Aug. 19	1471
Hilliard, H. J.	Sound View	1	Dec. 24	1577
Hiti Nurseries (J. H. Bowditch, Prop.)	Pomfret Center	9	Aug. 20	1475
Holcomb, Irving	Simsbury	1	Sept. 5	1494
Holdridge, S. E.	Ledyard	2	Dec. 31	1585
Hoogendoorn, C.	Yalesville	1	Aug. 22	1480
Horan & Son, Jas.	Bridgeport	1	Oct. 29	1559
Houston's Nurseries	Mansfield	4	Nov. 7	1562
Hoyt's Sons Co., Inc., The Stephen	New Canaan	250	Sept. 16	1507
Hull, Curtis M.	Wallingford	1	Oct. 24	1554
Hunt & Co., W. W.	Hartford	10	Oct. 4	1533
Isselee, Charles	Darien	10	Nov. 15	1564
Jones, William	Norwalk	1	Oct. 2	1524
Kelley, James J.	New Canaan	1	Nov. 28	1569
Kellner, Herman H.	Danbury	1	Oct. 1	1522
Keso Nursery (J. J. Kelsey, Prop.)	Clinton	1	Nov. 24	1568
Leghorn, John J.	Cromwell	1	Sept. 16	1505
Long Hill Nursery	Burnside	1	Dec. 22	1576
Mallett Co., George A.	Bridgeport	1	Oct. 14	1545
Maplewood Nurseries (T. H. Peabody, Mgr.)	Norwich	1	Oct. 3	1531
Marigold Farm (H. Kelley, Prop.)	New Canaan	6	Nov. 24	1567
Meier, A. R.	West Hartford	1	Oct. 25	1555
Millane Tree Expert Co., The	Middletown	1	Nov. 18	1565
New Haven Florist Co.	New Haven	1	Dec. 30	1579
New Haven Nurseries, The	New Haven	1	Aug. 28	1485
New Haven Park Commissioners (G. X. Amrhyn, Supt.)	New Haven	30	Aug. 28	1486
Newington Gardens	Newington	1	Oct. 2	1526
New London Cemetery Association (Ernest E. Rogers, Pres.)	New London	1	Oct. 3	1532
New London County Nurseries (W. J. Schoonman, Prop)	New London	5	Oct. 7	1538
New London Greenhouses and Nursery	New London	1	Oct. 21	1550
New Milford Nurseries	Northville	1	Sept. 30	1517
Nicolson & Thurston (2)	Litchfield	1	Oct. 15	1548
North-Eastern Forestry Co.	Cheshire	20	Aug. 14	1470
Norwood Nursery	Hamden	1	Oct. 6	1537
Oakland Nurseries	Manchester	5	Aug. 20	1477

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1924—*Con.*

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Outpost Nurseries (L. D. Conley, Prop.)	Ridgefield	25	Sept. 25	1513
Ouwerkerk & Van der Stam	Yalesville	7	Aug. 22	1479
Park Gardens	Bridgeport	1	Oct. 1	1521
Park Hill Flower Shop	Manchester	1	Sept. 9	1496
Pequod Nursery Co.	Yalesville	15	Aug. 27	1483
Phelps & V. T. Hammer Co., The J. W.	Branford	2	Oct. 11	1544
Pierson, A. N., Inc.	Cromwell	75	Aug. 22	1478
Polish Orphanage Farm (Rev. L. Bojnowski, Mgr.)	New Britain	1	Oct. 14	1546
Pomeroy, Edwin C.	Northville	1	Sept. 30	1516
Reck, Julius	Bridgeport	1	Nov. 28	1570
Reumann, Theodore	Stamford	1	Oct. 1	1520
Rockfall Nursery Co. (P. Marotta, Prop.)	Rockfall	40	Sept. 27	1515
Rowayton Greenhouses	Rowayton	1	Sept. 16	1503
Ryther, O. E.	Norwich	6	Nov. 5	1561
Saxe & Floto	Waterbury	1	Dec. 31	1584
Scheepers, Inc., John	Stamford	6	Dec. 13	1575
Scott, J. W.	Hartford	5	Dec. 2	1574
Sierman, C. H.	Hartford	5	Oct. 27	1557
South Wilton Nurseries	South Wilton	6	Nov. 19	1566
Stamford Seed & Nursery Co.	Stamford	1	Oct. 2	1525
Stannard Hill Greenhouse	Westbrook	1	Aug. 29	1488
Steck, Charles A.	Newtown	5	Oct. 28	1558
Steck, Mrs. Sarah B.	Bethel	1	Oct. 21	1551
Stratfield Nursery Co.	Bridgeport	10	Dec. 31	1581
Stratford Florist Co. (C. A. Cooper)	Stratford	1	Oct. 1	1523
Stratford Rose Nurseries (John Barrow, Prop.)	Stratford	1	Oct. 2	1530
Sunny Ridge Nursery (Charles A. Steck, Jr.)	Bethel	5	Oct. 2	1528
Tanner's Nursery Co.	Manchester	1	Aug. 27	1484
Tow Path Gardens (S. W. Eddy, Prop.)	Avon	1	Oct. 27	1556
Upson, R. E.	Marion	1	Oct. 9	1542
Vanderbrook & Son, Chas. L.	Manchester	5	Aug. 19	1472
Van Wilgen & Co.	Branford	15	Oct. 21	1552
Vasileff, Nicholas	Greenwich	1	Dec. 31	1582
Verkade's Nurseries	New London	20	Sept. 12	1500
Vidbourne & Co., Estate of J.	Hartford	3	Nov. 28	1571
Wallace Nursery	Wallingford	4	Sept. 2	1492
Wheeler, Chas. B.	No. Stonington	1	Oct. 6	1534
Wilcox, Harry D.	Avon	1	Oct. 2	1529
Wild, Henry	Greenwich and Norwalk	16	Sept. 25	1512
Wilson & Co., C. E.	Manchester	50	Sept. 19	1510
Woodruff, C. V.	Orange	1	Oct. 9	1543
Yale University School of Forestry	New Haven	1	Oct. 18	1549
Young, Mrs. Nellie A.	Pine Orchard	1	Dec. 27	1578
Zack, Co., H. J.	Deep River	4	Aug. 29	1489
Total acreage		1,779		

Inspection of Raspberry Plantations.

In addition to the inspection of nursery stock, some fruiting plantations were examined to ascertain whether or not they were free of the disease known as mosaic. This disease is not very well understood and its cause is not definitely known, but has at different times and by various investigators been supposed to be an enzyme or chemical ferment, and an ultra-microscopic germ or organism of bacterial or protozoan nature. Whatever may be the cause, it is fairly well established that it is transmitted by a small species of aphid, *Aphis rubiphila* Patch. This makes it somewhat analogous to the mosaic of potato which is transmitted by the potato aphid, *Macrosiphum solanifolii* Ashm.

Recently an attempt has been made in New York State to grow raspberry plants which are free from mosaic, and nurserymen are not allowed to ship raspberry plants into New York State unless some similar method of inspection and eradication is in practice in the State where the stock is grown. Similar action has been taken by the States of Ohio, Michigan and Minnesota. Consequently there were several applications for inspections on account of this disease, some from regular nurserymen, and others from owners of fruiting raspberry plantations.

As this problem required the co-operation of the Botanical and Entomological Departments, arrangements were made to visit New York State and learn the status of the raspberry inspection and the eradication of mosaic. By appointment, Messrs. Clinton and Hunt, Botanists, and Britton and Zappe, Entomologists, visited Poughkeepsie and Highland, N. Y., on July 10, where Dr. W. H. Rankin showed his work and gave the visitors all the information on the subject at his command. Evidently some varieties are much more susceptible to the disease than others, and it seems to be a difficult matter to grow the standard varieties of red raspberries and have them free from mosaic. The everbearing varieties, though not immune, are not commonly affected, and the black-caps and purple canes are not or almost never attacked. Blue stem and curly leaf are two other troubles apparently distinct from mosaic, though not well understood. The former is a disease of black-caps and the latter is found on red raspberries as well as is mosaic, though less common.

Shortly after returning to Connecticut, some inspections of raspberry plantations were made by Messrs. Zappe, Clinton and Hunt, beginning July 16 and extending through the regular inspection of nurseries. In a portion of the plantations of certain varieties, if much mosaic occurred, the owner expressed a desire to destroy the plants and not attempt to obtain a certificate. Certain other varieties were free or nearly free from mosaic and the diseased plants were removed or "rogued out" and a second inspection made a month or six weeks later. Thus it was possible

to grant certificates on certain varieties where it had to be refused on other varieties. Altogether, eight plantations were inspected and five special certificates granted. These certificates were signed by both the Botanist and the Entomologist. The list of growers receiving special raspberry certificates is as follows:

SPECIAL CERTIFICATES ON RASPBERRY PLANTS.

Name of Firm	Address	Variety	Certificate Issued	No. of Certificate
Barnes Bros. Nursery Company	Yalesville (Durham plantation)..	La France Latham King Red Path...	Oct. 10	3
Barnes Nursery and Orchard Company..	Wallingford...	Erskine Park St. Regis...	Oct. 10	4
Bertolf Brothers......	Greenwich....	La France..	Oct. 10	5
Croteau, Fannie......	Mount Carmel	St. Regis...	Sept. 15	1
Scheepers, Inc., John..	Stamford.....	La France..	Oct. 10	2

INSPECTION OF IMPORTED NURSERY STOCK.

The nursery stock imported from foreign countries and entering Connecticut during 1924 was inspected as in preceding years, mostly by Mr. Zappe, but assisted by Messrs. Botsford, Friend, Rogers and Walden. Though the number of shipments was slightly less than last year, there was an increase of about 75 per cent. in the number of cases and 71 per cent. in the number of plants. The following table shows the number of shipments, number of cases, and number of plants, inspected at destination, during each of the last five years:

Year	No. of Shipments	No. of Cases	No. of Plants
1920................	17	87	814,491
1921................	21	126	1,228,560
1922................	30	159	1,997,595
1923................	35	179	1,981,895
1924................	33	313	3,489,170

These 33 shipments were imported by eight different Connecticut firms, 24 of them being consigned to two firms. Most of the stock consisted of seedling fruit and Manetti rose, for grafting and budding. There were 14 shipments of fruit seedlings, and 19 shipments of rose stocks; two shipments contained both fruit and rose stocks.

The cost of inspecting this imported nursery stock was about $500.00.

As in preceding years, the bulk of the shipments came from France and Holland, with a few shipments from England and other countries. The sources of this stock inspected during the year were as follows:

SOURCES OF IMPORTED NURSERY STOCK, 1923-1924.

Country	No. of Shipments	No. of Cases	No. of Plants
France	13	164	2,033,600
Holland	12	119	1,126,070
England	6	21	259,500
Italy	1	2	10,000
Germany	1	7	60,000
	33	313	3,489,170

The following table shows the quantities of stock as inspected by months:

Month	No. of Shipments	No. of Cases	No. of Plants
November	2	5	105,000
December	4	25	229,500
January	6	66	720,820
February	17	174	1,984,900
March	4	43	448,950
	33	313	3,489,170

In addition to the material tabulated above, there were 13 shipments containing 16 packages of seeds, mostly of trees and palms, which were not inspected in Connecticut.

Of the 33 shipments of stock inspected, 17 shipments or 49 per cent. were found infested with insects or plant diseases, though most of them were not dangerous pests. Details regarding these pests are given below.

PESTS FOUND ON IMPORTED NURSERY STOCK.

17 Shipments Infested.

INSECTS.

Emphytus cinctus Linn., on Manetti rose. (15 shipments). S. Bide & Son, Ltd., Farnham, Surrey, England; W. Fromow & Sons, Windlesham, Surrey, England; W. C. Slocock, Woking, England; B. Ruys, Ltd., Dedensvaart, Holland; Franco-American Seedling Co., Angers, France; Georges Benard, Olivet-Orleans, France; Oudyh Brothers Nurseries, Boskoop Holland; Association Flora, Boskoop, Holland; H. K. Woldering, Veendam, Holland; M. Gielen, Oudenbosch, Holland; V. Levasseur & Sons, Ussy, Calvados, France; D. J. de Jonge, Sappemeer, Holland. On Fruit stock, Andre Choplin, Maze, France.

Lepidopterous pupae on apple. (3 shipments.) Andre Choplin, Maze, France; Franco-American Seedling Co., Angers, France. On Quince, Louis Leroy's Nurseries, Angers, France.

Notolophus antiqua Linn., on apple (1 shipment.) Franco-American Seedling Co., Angers, France.

PLANT DISEASES.

Crown Gall on Manetti rose. (4 shipments.) W. C. Slocock, Woking, England. On fruit stock, Andre Choplin, Maze, France; Franco-American Seedling Co., Angers, France.

INSPECTION OF APIARIES IN 1924.

In 1924, as in past years, the apiary inspection work has been done by Messrs. H. W. Coley of Westport and A. W. Yates of Hartford on a *per diem* basis. Mr. Coley covers the southern half of the State, comprising Fairfield, New Haven, Middlesex and New London Counties. Mr. Yates covers the northern half, composed of Litchfield, Hartford, Tolland and Windham Counties.

This work required a total of 159 man days and the entire cost for the season was $2,306.40.

More apiaries and more colonies were inspected in 1924 than have ever before been inspected in a single season. The following table shows the number of apiaries and colonies inspected, and the average number of colonies per apiary for each year since the inspection work was commenced in 1910.

Fifteen Year Record of Apiary Inspection in Connecticut.

Year	No. of Apiaries	No. of Colonies	Average No. Colonies per Apiary	Cost of Inspection Per Apiary	Per Colony
1910	208	1,595	7.6	$2.40	.28
1911	162	1,571	9.7	1.99	.21
1912	153	1,431	9.3	1.96	.21
1913	189	1,500	7.9	1.63	.21
1914	463	3,882	8.38	1.62	.19
1915	494	4,241	8.58	1.51	.175
1916	467	3,898	8.34	1.61	.19
1917	473	4,506	9.52	1.58	.166
1918	395	3,047	7.8	1.97	.25
1919	723	6,070	11.2	2.45	.29
1920	762	4,797	6.5	2.565	.41
1921	751	6,972	9.2	2.638	.24
1922	797	8,007	10.04	2.60	.257
1923	725	6,802	9.38	2.55	.27
1924	953	8,929	9.4	2.42	.25

In 1924, apiaries were inspected in 142 towns as against 119 towns in 1923, and 125 towns in 1922.

For the first time an inspection was made in the town of Union, as the inspector heretofore had been unable to learn of any bees in that town. On account of the law compelling registration, he obtained this information and made the inspection. However, it was only one apiary containing two colonies of bees.

In 1924 inspections were made in the following 35 towns not visited in 1923: *Fairfield County*: Brookfield, Ridgefield and Weston; *New Haven County*: East Haven, New Haven, North Branford, Wolcott and Woodbridge; *Middlesex County*: Portland and Westbrook; *New London County*: Colchester, Griswold, Ledyard, Lisbon, North Stonington, Salem, Sprague and Voluntown; *Litchfield County*: Bridgewater, Canaan, Cornwall, New Milford, Norfolk, North Canaan, Roxbury, Salisbury and Sharon; *Hartford*

County: Avon and Hartland; *Tolland County*: Stafford, Tolland, Union and Willington; *Windham County*: Ashford and Thompson.

In 1923, apiaries were inspected in the following 13 towns not visited in 1924: *Fairfield County*: Bethel; *Middlesex County*: Saybrook; *Litchfield County*: Harwinton and New Hartford; *Hartford County*: Bloomfield, East Granby, East Windsor, Granby, Suffield, Windsor and Windsor Locks; *Tolland County*: Bolton and Hebron.

European Foul Brood.

This disease is caused by *Bacillus pluton* which attacks and kills the young larvae in the cells, being more destructive in spring and early summer than in other seasons. The odor of fermentation is usually present but it is not very offensive and the contents of the cells are usually not gelatinous or ropy. The common remedy consists of requeening with Italian queens and having the colonies strong by uniting if necessary.

Of the 953 apiaries, and 8,929 colonies inspected in 1924, 17 apiaries and 47 colonies were found infested with European foul brood. This is 1.78 per cent. of the apiaries and .526 per cent. of the whole number of colonies inspected during the season. Though the percentage of colonies infested is somewhat larger than 1923, the percentage of infested apiaries is smaller than ever before. In fact this disease has shown almost a gradual reduction, due we believe to the system of inspection and better handling of apiaries, since the inspection work began in 1910, as the following table will show:

Record of European Foul Brood.

Year	Percentage of Infestation Apiaries	Colonies
1910	75.9	49.7
1911	51.8	27.4
1912	47.7	23.5
1913	44.4	24.5
1914	32.6	13.9
1915	26.1	10.3
1916	18.8	7.05
1917	16.7	4.86
1918	9.8	3.3
1919	6.6	1.2
1920	4.3	1.5
1921	3.99	1.26
1922	4.14	.85
1923	2.34	.36
1924	1.78	.526

During 1924, European foul brood was found only in Meriden and Waterbury, New Haven County; Durham and East Hampton, Middlesex County; Lebanon, Old Lyme, Salem and Stoning-

ton, New London County; Barkhamsted, Cornwall and Roxbury, Litchfield County; Hartland, Hartford County; Ellington, Tolland County; Brooklyn, Plainfield, Putnam and Sterling, Windham County. This disease was not found in any of the apiaries inspected in Fairfield County.

American Foul Brood.

American foul brood is also a bacterial disease caused by *Bacillus larvae,* and attacks the brood at a later stage than European foul brood. It usually shows itself at the time the larvae are mature and pupating, when the cells are sealed or capped. The diseased cells later become sunken and if broken open the contents emit an offensive odor, and have a peculiar stringy or ropy consistency. Shaking into clean hives, destroying all infected combs and disinfecting the old hives is the treatment. Almost the whole danger of a recurrence is careless treatment and reinfection from infected combs and honey. Some authorities are recommending and using an alcohol-formalin solution containing 20 per cent. formalin, in which tbey soak tbe combs to sterilize them, after which they can be safely used. This may prove of great value in stamping out the disease.

Of the 953 apiaries and 8,929 colonies inspected in 1924, 10 apiaries and 20 colonies were found diseased with American foul brood. This is 1.04 per cent. of the apiaries and .22 per cent. of the colonies, a slight increase in percentage of the apiaries and decrease in that of the colonies over last year. With American foul brood there has never been any gradual decrease as in the case of European foul brood, but spasmodic outbreaks have occurred here and there since 1914. The following table will show the percentages of apiaries and colonies found diseased with American foul brood since the beginning of inspection work in Connecticut.

Record of American Foul Brood.

Year	Percentage of Infestation Apiaries	Colonies
1910	0	0
1911	0	0
1912	0	0
1913	0	0
1914	1.07	.7
1915	.8	.18
1916	1.07	.15
1917	.42	.17
1918	1.01	.32
1919	3.	1.1
1920	1.18	.25
1921	2.5	.56
1922	1.38	.27
1923	.965	.323
1924	1.04	.22

During 1924, American foul brood was found in the towns of Greenwich and Shelton, Fairfield County; Naugatuck and Wallingford, New Haven County; Clinton, East Hampton and Haddam, Middlesex County; Old Lyme, New London County; Thomaston and Washington, Litchfield County. The disease was not found in any apiaries inspected during the season in Hartford, Tolland or Windham Counties.

The system of controlling this disease in some of the States is that known as the "area clean-up" method, and an attempt is made to eradicate the disease, working around the centers of infection. A movement has been started to procure Federal co-operation in this work.

Statistics of Inspection.

The statistics of apiary inspection by towns and counties may be found on the following pages, with summary on page 252.

Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased	American Foul Brood	European Foul Brood	Sacbrood	Paralysis
Fairfield County:								
Brookfield	4	0	56	0	0	0	0	0
Danbury	5	0	29	0	0	0	0	0
Darien	6	2	61	3	0	0	3	0
Easton	4	1	181	1	0	0	1	0
Fairfield	10	1	104	1	0	0	1	0
Greenwich	9	1	54	1	1	0	0	0
Monroe	4	0	88	0	0	0	0	0
New Canaan	5	0	63	0	0	0	0	0
Newtown	10	1	115	1	0	0	1	0
Norwalk	4	0	37	0	0	0	0	0
Redding	3	0	22	0	0	0	0	0
Ridgefield	6	1	22	1	0	0	1	0
Shelton	3	1	47	2	2	0	0	0
Stamford	21	0	187	0	0	0	0	0
Stratford	2	0	14	0	0	0	0	0
Trumbull	4	0	57	0	0	0	0	0
Weston	2	0	11	0	0	0	0	0
Westport	5	0	26	0	0	0	0	0
Wilton	12	0	161	0	0	0	0	0
	119	8	1,335	10	3	0	7	0
New Haven County:								
Beacon Falls	3	0	52	0	0	0	0	0
Branford	3	0	12	0	0	0	0	0
Cheshire	8	0	71	0	0	0	0	0
Derby	3	1	16	1	0	0	1	0
East Haven	2	0	22	0	0	0	0	0
Guilford	5	0	59	0	0	0	0	0
Hamden	8	0	107	0	0	0	0	0
Madison	3	1	32	1	0	1	0	0

APIARIES INSPECTED IN 1924—*Continued.*

Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased	American Foul Brood	European Foul Brood	Sacbrood	Paralysis
New Haven County: —*Concluded.*								
Meriden	25	2	208	2	0	0	2	0
Milford	5	0	69	0	0	0	0	0
Naugatuck	6	2	19	2	1	0	1	0
New Haven	3	0	14	0	0	0	0	0
North Branford	2	0	50	0	0	0	0	0
North Haven	11	1	158	2	0	0	2	0
Orange	2	0	10	0	0	0	0	0
Prospect	9	0	79	0	0	0	0	0
Seymour	1	0	10	0	0	0	0	0
Wallingford	23	6	145	8	4	0	4	0
Waterbury	10	1	71	2	0	2	0	0
West Haven	3	0	30	0	0	0	0	0
Wolcott	2	0	7	0	0	0	0	0
Woodbridge	2	1	27	1	0	0	1	0
	139	15	1,268	19	5	3	11	0
Middlesex County:								
Chester	5	0	48	0	0	0	0	0
Clinton	8	5	71	20	2	0	18	0
Cromwell	7	0	37	0	0	0	0	0
Durham	7	2	136	2	0	1	1	0
East Haddam	7	0	172	0	0	0	0	0
East Hampton	10	2	117	2	1	1	0	0
Essex	4	0	67	0	0	0	0	0
Haddam	4	2	50	5	5	0	0	0
Killingworth	7	1	38	4	0	0	4	0
Middlefield	3	0	91	0	0	0	0	0
Middletown	10	0	104	0	0	0	0	0
Old Saybrook	6	1	67	2	0	0	2	0
Portland	8	0	45	0	0	0	0	0
Westbrook	2	0	9	0	0	0	0	0
	88	13	1,052	35	8	2	25	0
New London County:								
Bozrah	3	0	112	0	0	0	0	0
Colchester	9	0	43	0	0	0	0	0
East Lyme	3	0	56	0	0	0	0	0
Franklin	1	0	24	0	0	0	0	0
Griswold	4	1	89	2	0	0	2	0
Groton	6	0	31	0	0	0	0	0
Lebanon	10	1	144	1	0	1	0	0
Ledyard	1	0	18	0	0	0	0	0
Lisbon	2	0	43	0	0	0	0	0
Montville	6	0	83	0	0	0	0	0
New London	5	0	90	0	0	0	0	0
No. Stonington	2	0	27	0	0	0	0	0
Norwich	13	1	425	2	0	0	2	0
Old Lyme	3	1	61	2	1	1	0	0
Preston	7	0	49	0	0	0	0	0
Salem	2	1	42	1	0	1	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APIARIES INSPECTED IN 1924—*Continued.*

Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased	American Foul Brood	European Foul Brood	Sacbrood	Paralysis
New London County: —*Concluded.*								
Stonington	8	1	63	1	0	1	0	0
Voluntown	1	0	14	0	0	0	0	0
Waterford	7	0	52	0	0	0	0	0
	95	6	1,505	9	1	4	4	0
Litchfield County:								
Barkhamsted	4	2	41	10	0	10	0	0
Bethlehem	2	0	8	0	0	0	0	0
Bridgewater	12	0	91	0	0	0	0	0
Canaan	5	0	28	0	0	0	0	0
Colebrook	2	0	5	0	0	0	0	0
Cornwall	9	3	40	4	0	4	0	0
Goshen	3	0	29	0	0	0	0	0
Litchfield	19	0	122	0	0	0	0	0
Morris	5	0	27	0	0	0	0	0
New Milford	11	0	101	0	0	0	0	0
Norfolk	6	0	24	0	0	0	0	0
North Canaan	5	0	65	0	0	0	0	0
Plymouth	9	0	51	0	0	0	0	0
Roxbury	4	1	21	2	0	2	0	0
Salisbury	8	0	49	0	0	0	0	0
Sharon	3	0	68	0	0	0	0	0
Thomaston	12	1	39	1	1	0	0	0
Torrington	2	0	7	0	0	0	0	0
Washington	7	1	121	2	2	0	0	0
Watertown	5	1	19	2	0	0	0	2
Winchester	7	1	44	1	0	0	0	1
Woodbury	9	0	65	0	0	0	0	0
	149	10	1,065	22	3	16	0	3
Hartford County:								
Avon	3	0	4	0	0	0	0	0
Berlin	12	0	255	0	0	0	0	0
Bristol	19	0	97	0	0	0	0	0
Burlington	8	0	38	0	0	0	0	0
Canton	12	0	80	0	0	0	0	0
East Hartford	1	0	3	0	0	0	0	0
Enfield	3	0	11	0	0	0	0	0
Farmington	11	0	66	0	0	0	0	0
Glastonbury	24	0	164	0	0	0	0	0
Hartland	1	1	103	2	0	2	0	0
Manchester	10	0	70	0	0	0	0	0
New Britain	18	0	148	0	0	0	0	0
Newington	8	0	66	0	0	0	0	0
Plainville	12	1	25	2	0	0	0	2
Rocky Hill	5	0	47	0	0	0	0	0
Simsbury	8	0	37	0	0	0	0	0
Southington	14	0	80	0	0	0	0	0
South Windsor	14	0	120	0	0	0	0	0
West Hartford	26	0	168	0	0	0	0	0
Wethersfield	5	0	30	0	0	0	0	0
	214	2	1,612	4	0	2	0	2

APIARIES INSPECTED IN 1924—*Concluded.*

Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased	American Foul Brood	European Foul Brood	Sacbrood	Paralysis
Tolland County:								
Andover	5	0	27	0	0	0	0	0
Columbia	3	0	15	0	0	0	0	0
Coventry	11	0	75	0	0	0	0	0
Ellington	15	3	67	4	0	4	0	0
Mansfield	4	1	46	1	0	0	0	1
Somers	3	0	19	0	0	0	0	0
Stafford	6	0	25	0	0	0	0	0
Tolland	6	0	35	0	0	0	0	0
Union	1	0	2	0	0	0	0	0
Vernon	7	0	32	0	0	0	0	0
Willington	9	0	47	0	0	0	0	0
	70	4	390	5	0	4	0	1
Windham County:								
Ashford	1	0	16	0	0	0	0	0
Brooklyn	5	1	177	1	0	1	0	0
Canterbury	3	0	26	0	0	0	0	0
Chaplin	1	0	1	0	0	0	0	0
Eastford	3	0	11	0	0	0	0	0
Hampton	7	0	78	0	0	0	0	0
Killingly	11	0	48	0	0	0	0	0
Plainfield	24	4	114	12	0	12	0	0
Pomfret	3	0	8	0	0	0	0	0
Putnam	5	1	36	1	0	1	0	0
Sterling	3	1	11	2	0	2	0	0
Thompson	4	0	47	0	0	0	0	0
Windham	6	0	84	0	0	0	0	0
Woodstock	3	0	45	0	0	0	0	0
	79	7	702	16	0	16	0	0

SUMMARY.

County	No. Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased	American Foul Brood	European Foul Brood	Sacbrood	Paralysis
Fairfield	19	119	8	1,335	10	3	0	7	0
New Haven	22	139	15	1,268	19	5	3	11	0
Middlesex	14	88	13	1,052	35	8	2	25	0
New London	20	95	6	1,505	9	1	4	4	0
Litchfield	22	149	10	1,065	22	3	16	0	3
Hartford	20	214	2	1,612	4	0	2	0	2
Tolland	11	70	4	390	5	0	4	0	1
Windham	14	79	7	702	16	0	16	0	0
	142	953	65	8,929	120	20	47	47	6

	No. Apiaries	No. Colonies
Inspected	953	8,929
Infested with European foul brood	17	47
Per cent. infested	1.78	.526
Infested with American foul brood	10	20
Per cent. infested	1.04	.22
Sacbrood	17	47
Bee paralysis	4	6
Average number of colonies per apiary		9.4
Cost of inspection		$2,306.40
Average cost per apiary		2.42
Average cost per colony		.25

Registration of Bees.

There is still much confusion regarding the registration of bees, and many beekeepers are not complying with the law. Some beekeepers think that if they register once, they need not do so again. Certain others probably have never registered their bees; though they are subject to a five dollar fine for not doing so on or before October 1. Apparently the law is not enforced in most towns. In the town of Stafford, one beekeeper who failed to register on the date prescribed was prosecuted and fined. I have not heard of another similar case. The law, Chapter 174, Public Acts of 1919, as amended in Chapter 129, Public Acts of 1923, is as follows:

"Section 1. Every person owning one or more hives of bees shall, annually, on or before the first day of October, make application to the town clerk of the town in which such bees are kept, for the registration of such bees, and such town clerk shall issue to such applicant a certificate of registration upon the payment of a recording fee of twenty-five cents, which certificate shall be in the form prescribed and upon blanks furnished by the commissioner of domestic animals and shall be recorded in the office of such town clerk.

Sec. 2. A record of such registration and of the name and place of residence of the registrant and the definite location in the town where bees are kept by him shall be kept in a separate book in the office of the town clerk, which record shall be accessible to the public. Each town clerk shall file with the state entomologist of the Connecticut Agricultural Experiment Station a complete list of such registrations and locations on or before the first day of February of the year succeeding such registrations. Any town clerk failing to perform such duty shall be fined not more than ten dollars."

Sec. 3. Any owner of bees who shall fail to register as required by the provisions of this act shall be fined not more than five dollars."

According to records in this office, 1,416 beekeepers registered in the State in 1923, yet the inspections of 1924 contained 166 names that were not registered the preceding October. As only 923 apiaries were inspected in 1924, which is less than two-thirds of the number registered, there must have been considerably more than 166 beekeepers who failed to register. Moreover, it is rather difficult to obtain complete data from the town clerks.

Of course the law does not compel them to report to the State Entomologist in case no bees have been registered in a given town. Yet unless they do report, the State Entomologist has no way of knowing whether none were registered or whether registrations were made and the clerk failed to report them. Repeated requests and considerable correspondence have been necessary to obtain from the town clerks even an approximate record of the beekeepers who have registered throughout the State.

All beekeepers should each year on or before October 1, register with the town clerk in the towns where their bees are kept.

All town clerks should report complete data regarding such registration to the State Entomologist. They need not wait to do this but may report any time after October 1, and must do so on or before February 1, following such registration.

REPORT OF GIPSY MOTH WORK.

Year Ending June 30, 1924.

By W. E. Britton and John T. Ashworth.

This work has been conducted as in former years by State and Federal agencies working in co-operation, the Federal agencies expending their efforts near the margin of the area known to be infested in order to prevent further spread and the State forces working within the infested area in order to hold the pest in check. This co-operation has proven very satisfactory and we hereby wish to express our appreciation and thanks to Mr. A. F. Burgess, in charge of moth work and Mr. H. L. Blaisdell, in charge of field work, both of the Federal Bureau of Entomology.

A somewhat detailed account of how the work is organized and prosecuted was published in the 22nd Report of the State Entomologist, page 290 (see Report of Connecticut Agricultural Experiment Station for 1922, page 290) and need not be repeated here. The fact that a larger area is now infested than was known to be infested at that time does not mean that the pest has been spreading rapidly during this period. The explanation lies rather in the extensive windspread of May, 1920, and possible additional spread of 1921, the limits of which have only recently been discovered. Both Federal and State funds have not been adequate to cover all suspected territory in any one season.

New Equipment.

The Buick touring car purchased in 1921 was exchanged March 31, 1924, for a new Buick of similar type.

One new Ford light delivery truck was purchased on December 24, 1923.

As some of the spray hose had seen its best days, it was necessary to replace it, and five hundred feet were purchased on June 23, 1924, from the Acme Rubber Company of Boston, Mass.

The above-mentioned articles, together with a few small tools such as pliers, screw drivers and hammers, comprise the new equipment for the year.

Details of Infestations.

WINDHAM COUNTY.

As Windham County lies nearest to the center of the large infested region in New England and was the first county in the State to become generally infested with the gipsy moth, it may rightly be regarded as the most densely infested portion of Connecticut. Such is the case. The following table will show the conditions in the county in 1923 as compared with those in 1917, but does not include the towns of Thompson, Woodstock, Putnam and Plainfield, where the scouting was not completed this year.

Year	Colonies Found	No. of Egg-Clusters	Colonies Sprayed
1917............	245	3,758	45
1923............	150	3,089	114

By comparing these figures, it will be seen that the control measures taken and the work done have not been in vain. Parasites have been liberated over the entire county and it is our aim to collect egg-masses in this district this season to determine whether or not they have become established and to what extent they are working.

The following is a brief summary of the work done in each town in the county. In Brooklyn, though no large colonies were found, one of 34 egg-clusters in woodland owned by John Harrington a little west of the Old Trinity Church, and another of 23 egg-clusters in oaks in the Quinebaug mill yard, were the two largest colonies found in the town. Fifteen of the 16 colonies were sprayed by State men in the summer.

Canterbury was scouted in the early fall, and the infestations found were all in the northern half of the town. Three small colonies were found just south of Westminster village, and all others were north of this region. The largest was one of 83 egg-clusters in mixed woodland and a stone wall on land owned by Sherman Galloway in the northwestern part of the town, near the Hampton line. Ten of the 13 infestations were sprayed by State men in June.

One of the five colonies found in Chaplin contained 24 egg-clusters, but the others were all small. Seven single egg-clusters were also found scattered widely over the town. The above-mentioned infestation was found in two white oaks on a woodland edge owned by John Evans in the extreme northwestern corner

of the town near the Ashford line. All five of the colonies were sprayed by State men during June.

Hampton was scouted the latter part of August, four colonies and five singles being found. The colonies were all small, the largest containing 17 egg-clusters on apple trees and in a stone wall on an abandoned farm in the northern end of the town about one quarter mile from the Ashford town line. Three of the colonies were sprayed in June by State men.

Killingly was used as a school for training new men this year. The result shows the town to be infested generally, and that there are several large colonies. Four of the largest will be described in this report. The largest one had 490 egg-clusters on willow, maple and apple trees located on Mechanics Street, Danielson. The willow trees were badly infested, and most of the egg-clusters were found on them. Another colony of 96 egg-clusters was found in woodland owned by Mrs. Simmons and Mrs. Clement located nearly on the Rhode Island State line in the southeastern part of the town. One of 73 egg-masses was found in woodland owned by E. T. Kelley near the Plainfield town line on the east side of Snake meadow brook. The fourth one contained 46 egg-masses on apple and oak trees along the edge of woodland owned by T. E. Hopkins near the Hygeia water reservoir. There were a number of other colonies containing from 15 to 25 egg-clusters each. During the summer, 63 of the 88 infestations in the town were sprayed by State men.

Plainfield was only partly scouted this year, about 20 miles of road in the southern part of the town being done. One colony of 16 egg-clusters and seven single egg-cluster infestations were found. The colony was on a white oak on the roadside at Joe Bole's place, located in the south center of the town near the Griswold town line. This place was sprayed in the summer by State men.

As in the case of Plainfield, Putnam was only about one-fourth scouted, the work being done in the eastern end of the town, where five colonies and four single egg-clusters form the total. None of the colonies were large, 16 egg-clusters in an apple orchard at Cady's corner being the largest. Three of the colonies were sprayed in the summer by State men.

In Scotland, the work was confined to the territory around last year's infestations on account of the lateness in the season when this town was reached. Two small colonies of seven egg-clusters each were found in the center of the town near the post office, one on land owned by Charles Wheeler and the other on land owned by Louis B. Crosby. One single egg-mass was found in an apple tree owned by Mr. Romson located in the extreme northwestern corner of the town. Both of the seven egg-cluster colonies were sprayed in June by State men.

Twenty colonies were discovered in Sterling this year, only two

of them being very large. One of 85 egg-clusters was found in an orchard owned by Mr. Brown, about one and a half miles north of Oneco village. The other contained 56 egg-clusters in an oak owned by E. Wicks, about two and a half miles north of the above-mentioned colony. Fifteen of these colonies were sprayed in June by State men.

About 26 miles of roadside scouting were done in the town of Thompson by men who were being trained. This took in nearly the whole northeastern quarter of the town. Eighteen colonies were found, all small except two; one of 128 egg-clusters in an apple orchard and stone wall on land owned by Allen Bixby along the State road connecting Brandy Hill and Webster, Mass., near the Midland division railroad crossing; the other was in woodland at the northern end of Quadick Reservoir owned by Sheriff Bates, where 60 egg-clusters were found. Fifteen of the 18 places were sprayed during the last of June and first of July by State men.

Windham was one of the last towns to be scouted this year, and the spraying season came on before the work was completed. Thirty-five miles of roadway were covered and only one colony of six egg-clusters could be found. This was in an oak tree in a pasture owned by William F. Spokesfield in South Windham.

The scouting done in Woodstock was started in the late spring and the men kept at it until the spraying crew overtook them. Spraying was stopped on July 12, for by that time the larvae were nearly mature, and eating very little. Spraying under such conditions does very little good. Seventy infestations were found in the northern half of the town that was covered; single egg-clusters where larvae were found feeding were sprayed the same as colonies of five or more egg-clusters each. No very large colonies were found, four of the largest being as follows: one of 67 egg-clusters in a roadside oak owned by Edward Chamberlin near the north end of Roseland Lake; another of 50 egg-clusters in an orchard and woodland owned by L. M. Dodge in the northwestern corner of the town near the Massachusetts line; two others, one of 44 and one of 43 egg-clusters on land owned by Mr. Redhead and I. A. Paine respectively, located about two miles west of the North Woodstock post office, both in apple orchards. Sixty-five places were sprayed by State men in Woodstock this spring.

TOLLAND COUNTY.

Coventry was scouted by State men this year. The three largest colonies were found in a straight line east and west along the northern end of the town nearly parallel with the Tolland line. The other four infestations were small and widely scattered. One of the above mentioned colonies was in apple and oak trees in a pasture owned by Phineas Talcott, and contained 13 egg-clusters. Another of 17 egg-clusters was found in an old apple tree

on land owned by S. R. Carpenter, and the third had 11 egg-clusters in an orchard owned by W. R. Hawkins. Spraying was done at two of these places on June 17 by State men.

The scouting done in Ellington was in the sections of the town where infestation occurred last year, and all but two of the infestations were found on or near the Vernon and Somers State road. These were all small, one of 14 egg-clusters in Mr. Kobbe's orchard near the Somers line being the largest, and another of nine egg-clusters in an orchard and wall owned by Frank Gotcha about two miles east of the colony just described. On June 13, five of the colonies in Ellington were sprayed by State men.

Several large colonies were discovered in Mansfield this year. The town is generally but lightly infested. Three of the largest colonies may be described as follows: one of 68 egg-clusters was found in shade trees in the dooryard of W. H. Dumack in the extreme southwestern corner of the town; another of 60 egg-clusters in an orchard owned by Mr. Early in Mansfield Center; the last was a colony of 53 egg-clusters in apple and plum trees owned by Bark Shelchofer in the Merrow district. Thirteen colonies were sprayed in June by State men.

The three infestations found in Somers this year were discovered by a Federal man while making collections and observing the date of the first hatching of larvae in this section of New England. They were cleaned up and creosoted by State men, and also two of the places sprayed on June 12. None were large colonies, the largest being one of 18 egg-clusters in two apple trees in a pasture owned by Mr. Miller. Another of six egg-clusters was in two apple trees in a pasture owned by F. Kibbe in the village of Somers. A third infestation of two egg-clusters was found in an orchard about one and a half miles north of the two colonies just mentioned and owned by H. N. Kibbe.

On account of the lateness in the season when scouting was taken up in Tolland, the work was confined to the territory around last year's infestations. Scouting was done in an area about one mile outside each place where the gipsy moth was found last year, but nothing was found at any of these places.

Similar work was done in Vernon, and no egg-clusters were found in the town.

In Willington, nearly all the infestations were found in the northern half of the town, the largest one being in an orchard owned by Frederick Draper, about a mile east of West Willington post office, containing 33 egg-clusters. Another of 32 egg-clusters was found in an orchard owned by Felix Kash on the State road leading to Stafford Springs, about one mile south of the Stafford line. Twenty-five egg-clusters were found in an orchard owned by Emery Kucko in the north center of the town. The other colonies were nearly all under five egg-clusters each, and 11 places were sprayed in June by State men.

HARTFORD COUNTY.

The scouting in Hartford County was all done by State men this year and every town in the county was fully scouted except Marlborough. In Bristol, Canton, Glastonbury, Manchester, Newington, Plainville, West Hartford and Windsor Locks no gipsy moth infestations were found.

In Avon, one colony of 12 old egg-clusters was found on oaks in woodland owned by Edward Lasing, near the center of the township. In the spring after hatching had started, men were sent to look for larvae or signs of feeding there, but as none were found, no further work was thought necessary.

One colony of four egg-clusters was found in Berlin on a roadside maple on the property of Ralph R. Carter, near the Hartford State road just south of Berlin village. On June 18, this colony was sprayed by Federal men.

Four of the six infestations found in Bloomfield were situated within one mile of the post office and the other two were in the northwestern part of the town. The largest colony contained 40 egg-clusters on willow and oak trees owned by William Sherman at the first four corners west of the post office. The next largest colony was on apple trees owned by Miss Isabelle Tollar in the northwestern part of the town, where 13 egg-clusters were found. The other infestations were small. All six places were sprayed on June 19 by Federal men.

In Burlington, two colonies were found this year, one of 14 egg-clusters in an orchard owned by Mr. K. Szuster in the northwestern part of the town, and another of nine egg-clusters also in an orchard, in the southwestern corner of the town and owned by Mr. Christian Dichal. The first colony mentioned was sprayed June 21 and the other June 25 by Federal men.

Three infestations were found in East Granby this season. Two of them were large ones for this territory, although not hard to reach and control. The first was one of 70 egg-clusters found on willow trees and fence posts owned by Mr. Vitten about one-half mile north of the post office. The next largest was one of 63 egg-clusters on trees in a yard owned by E. W. Kellogg in the extreme northwestern part of the town. One small colony of two egg-clusters was found in an orchard owned by J. R. Holcomb. All three of the infestations were sprayed by Federal men on June 25.

East Hartford was scouted during the last of March and the first of April. One colony was found along the Connecticut River bank just north of the bridge on land owned by the Hartford Bridge Commission, where 31 egg-clusters were found on four willow trees. Two other small infestations were found in the town. Two places were sprayed on June 11 by State men.

Four small infestations were found in East Windsor, the largest colony containing seven egg-clusters, in an orchard owned by

Mrs. A. E. Haynes in the eastern part of the town. The other three infestations contained one, two and three egg-clusters respectively. Three of these infestations were sprayed on June 11 by State men.

In Enfield, one colony of 10 egg-clusters and three smaller ones were found. They were widely separated, there being one on each side of the town. The colony mentioned above was found in oaks on land owned by Andrew Gornet in the southeastern corner of the town. All four of the places were sprayed June 12 by State men.

In Farmington, two colonies and one single egg-cluster were found this year. Thirty-five egg-clusters were found in apple trees on land owned by John Wall about one mile west of the village. The other colony was in woodland owned by Charles Beech in the extreme northeastern corner of the town, where there were 28 egg-clusters on 10 different trees. Both these colonies were sprayed in the spring by Federal men. Twelve acres of woodland were sprayed at the woodland colony.

Five infestations were found in Granby this year, containing a total of 159 egg-clusters. Of this number, 145 egg-clusters were found in woodland owned by Max Shinder in the southwestern corner of the town near the Canton line. The Federal men sprayed three of the infestations on June 23.

Six colonies were found in Hartford this season. Five of them had over 15 egg-clusters each, and one in particular was a very large colony. This infestation was situated near the river east of the Fuller Brush Company's factory on Windsor Avenue. Nine hundred and thirty-six egg-clusters were found on willow, oak and maple trees here. This colony was one of the hardest to control of any found in the entire State this year, as the land was under water nearly all this spring. Spraying was done, however, by Federal men about the middle of June, 625 pounds of dry lead arsenate being used in the operation. A colony of 25 egg-clusters was found on Farmington Avenue; one of 15 egg-clusters on West Boulevard on apple and maple trees owned by Mr. Kenneth French; a colony of 27 egg-clusters on apple, elm and willow trees near the brook west of Hillside Avenue; one of 22 egg-clusters on apple trees and rose bush in yard owned by A. O. Doule on Allen Place; and the last was a colony of 24 egg-clusters found on New Britain Avenue at the Kings Daughters House, on apple and poplar trees, and on the foundation and sides of the house. All the colonies were sprayed by Federal men in June.

Hartland had five infestations found in it this year, with a total of 29 egg-clusters; 15 were in an orchard owned by the T. A. Howell Estate in the northwestern part of the town; the other infestations were small. Four of the colonies were sprayed by Federal men in July.

In New Britain three single egg-cluster infestations and one colony of 110 egg-clusters were found in oak trees, on houses, hen coops and fences on Bassett Street opposite the High School. This colony was sprayed June 21 by Federal men.

One large colony containing 137 egg-clusters was found in Rocky Hill on a pasture oak owned by Thomas Griswold, in the center of the township. This colony was sprayed by Federal men on June 11.

A small woodland colony of five egg-clusters was found in Southington on land owned by Charles Stewart in the southeastern corner of the town near the Meriden town line.

The two colonies found in South Windsor were both in the northwestern part of the town; one of 18 egg-clusters was in two apple trees in a field owned by Paul Banker and the other was in an orchard owned by H. F. Farnham. Both of these places were sprayed on June 11 by State men.

The town of Suffield was found to have 17 infestations scattered over the entire township. Some were quite large; one colony in particular in willow trees on land owned by Miss Antoinette Clark about one mile north of the village, near the State road leading to Enfield contained 650 egg-clusters. There were two other large colonies, one in an orchard owned by William Carney of Hasting Hill, containing 50 egg-clusters, and the other in four willow trees on Holiday Avenue, owned by Walenta Drenscak, containing 45 egg-clusters. The other infestations were small. Sixteen of the 17 infestations were sprayed in June by Federal men.

In Simsbury two infestations were found, one along both sides of the State road just south of the village, on land owned by The Ensign-Bickford Company, containing 458 egg-clusters, on oak, apple and elm trees. The other was a small colony of three egg-clusters in an orchard owned by Anson P. Tyler in the western end of the town near the Canton town line. Both colonies were sprayed by Federal men. At the larger colony, 1,125 pounds of dry lead arsenate (making 18,000 gallons of spray mixture) were used.

In Wethersfield, four infestations containing 626 egg-clusters were found; 622 were on apple, maple and willow trees on both sides of the road running east from the village toward the Connecticut River, on land owned by Messrs. Rusti, Crane, T. Smith and Hale. The other three infestations were all close by and may be regarded as a natural spread from the large colony. Three of the places were sprayed in June by Federal men.

Three of the five infestations found in Windsor this year were close together in the southern end of the town near the Hartford line. The largest was one of 73 egg-clusters on willow and walnut trees in a field owned by J. M. Sloan; another just north of this colony had 16 egg-clusters on willow trees owned by George

Reed. One colony of 17 egg-clusters was found in an oak tree owned by William Kennedy in the northwestern part of the town. Four of the colonies were sprayed by Federal men on June 20.

LITCHFIELD COUNTY.

A large portion of the territory in Litchfield County was covered by the Federal men, including the following towns where no infestations were found: Bethlehem, Bridgewater, Canaan, Kent, North Canaan, Roxbury, Sharon, Warren, Watertown, Washington and Woodbury. Harwinton was scouted by State men and nothing found. The following is a description of the infestations in Litchfield County.

Barkhamsted was scouted by State men and three infestations discovered. All were small ones and in apple orchards. One colony was sprayed June 9 by Federal men.

State men scouted Colebrook and five infestations were found, three of which are herein described. The largest was one of 16 egg-clusters on apple and maple trees owned by L. J. Phelps near the Norfolk line. Another of 11 egg-clusters was in an apple orchard just east of Colebrook post office owned by W. E. Lewis. The third colony was a peculiar one, containing 10 male and 25 female pupae in cavities in old apple trees owned by G. C. McKenzie about half way between the two colonies mentioned above. The moths had all emerged but not a single egg-cluster could be found. Four of the infestations were sprayed in June by Federal men.

Cornwall was scouted by Federal men, one colony of 46 egg-clusters being found in the southern part of the town about one mile west of East Cornwall village, in woodland owned by W. C. Clark. Over 14 acres of woodland was sprayed here by Federal men in the summer.

One four egg-cluster colony was found in New Hartford by State men in an apple tree owned by Koch Brothers, about two miles west of the New Hartford post office. It was sprayed on July 9 by Federal men.

All work in New Milford was done by Federal men. One colony of 35 egg-clusters was found in woodland owned by F. L. Wanger and H. T. Erickson in the southern end of the town near the New Fairfield line. About 26 acres of woodland were sprayed.

The scouting in Plymouth was done by State men and confined to the territory around last year's infestation, but nothing was found.

Two infestations were found in Salisbury, both of them on property owned by Thomas Bornetti, about a mile north of the Salisbury post office. Eight egg-clusters were found at both places, and about four acres of woodland sprayed, all the work being done by Federal forces.

Torrington and Winchester were both scouted by State men. One old egg-cluster was found in each town. No further work was thought necessary.

NEW LONDON COUNTY.

East Lyme was scouted by State men this year the latter part of April and the first of May. One colony of 10 egg-clusters was found in woodland oaks owned by Mr. Dennison located on the road leading to Black point. This colony and woodland around it to the extent of one acre were sprayed in the summer by State men.

About 84 miles of roadside scouting was done in Griswold this spring by a State crew, the largest colony found being one of seven egg-clusters in woodland owned by William Sullivan in the northeastern corner of the town near the Plainfield town line. Another of five egg-clusters was found in white oaks in the village of Glasko. The five other infestations were all smaller. Four of the seven places were sprayed by State men about the middle of June.

There were three clusters of infestations found in Groton this year, one in each of the villages of Groton, Noank and Mystic river; in the remainder of the township only five scattered colonies were found. The infestations were all small, 15 egg-clusters being the largest; these were in apple trees owned by Charles Heath and Charles Benjamin, located on the State road just west of Mystic River village. The next largest was in Noank on maple and apple trees owned by H. E. Bently, where 13 egg-clusters were found; the other infestations were nearly all under five egg-clusters each. Spraying was done at 12 of the 19 infestations this summer by State men.

In Lisbon three of the four infestations found were in the southern part of the town near the Quinebaug River, and the fourth was a single egg-mass in an orchard in the northern part of the town. There were two colonies large enough to mention; one of 21 egg-clusters found in apple and oak trees on land owned by Sherman Waters, and the other contained nine egg-clusters in an orchard belonging to Paul Geist. Both colonies were along the river; three of the infestations were sprayed on June 14 by State men.

One colony of 14 egg-masses was found in an old apple tree in Mr. John Barko's pasture in Montville this season. This tree was cut down and split open and the egg-clusters creosoted. No further work was thought necessary at this colony.

In New London two infestations were found, one of four egg-clusters on apple trees in the yard of Mr. E. N. Crocker, and the other of three egg-clusters on maple shade trees on town property. Both of these infestations were sprayed June 10 by State men.

Five infestations were found in Norwich, with a total of 31 egg-clusters. Over half of them were found at one place, in an

apple tree and stone wall in a pasture owned by Louis Webber in the district known as East Great Plain, containing 17 egg-clusters. The other four colonies were all small, five egg-clusters being the largest. Three of the five infestations were sprayed June 13 by State men.

The scouting in Old Lyme was confined to the sections of the town where gipsy moth infestations were found last year, namely, the northeastern and southwestern parts of the township. About 50 miles of roadside scouting was completed and nothing found.

One hundred and ninety-five egg-clusters were found in Preston, of which 144 were in two colonies. The first to be mentioned was the largest and was found in a white oak and stone wall in a pasture owned by Mr. Boswell, just west of Preston village on the south side of Prospect Hill, containing 122 egg-clusters. The next largest was one of 22 egg-masses, found on oak and apple trees in H. L. Harris' yard in the west end of the town near Laurel Hill; the four other colonies were small. All but one of these colonies were sprayed in June by State men; this one could not be reached with the hose available.

On account of the lateness of the season when reached, the scouting in Voluntown had to be confined to the areas around last year's infestations as larvae were already hatching. Three infestations were found, none of them large. Two of the colonies were close together in the southwestern corner of the town near the Griswold line; one contained seven and the other three egg-clusters. It was impossible to spray at these places as the road was impassable for the sprayer truck. The single egg-mass infestation found on an apple tree owned by Mr. Wilcox near the pond in Great Meadow Brook was sprayed as larvae were found feeding when the egg-cluster was discovered. This work was done by State men.

One egg-cluster was found in Waterford and the larvae had already hatched and were feeding. This egg-mass was in an apple orchard owned by G. W. Peabody, located about one mile north of Manetock Hill near Jordan Brook. This infestation was sprayed June 11 by State men.

MIDDLESEX COUNTY.

Only one town, Cromwell, in Middlesex County was completely scouted this year, though two other towns were partly scouted, all the work being done by State men.

In Cromwell, no egg-clusters were found.

Old Saybrook was scouted only around last year's infestations and nothing was found.

In Middletown, similar methods were used and one new egg-cluster found on an apple tree in an orchard owned by C. L. Johnson near Bear Hill. This egg-cluster was found just outside last last year's infestation at Mr. Johnson's place. Spraying was considered unnecessary.

NEW HAVEN COUNTY.

Two towns in New Haven County, Hamden and New Haven, were found to be infested this year, one colony being found in each town. That in New Haven was at 387 Howard Avenue, just south of the railroad bridge in three trees and on shrubs in a yard owned by M. J. Paxson, and contained six egg-clusters. The spraying was done on May 31 by State and Federal men.

The infestation in Hamden contained four egg-clusters and spraying was thought unnecessary. Federal men scouted these towns, and also Bethany, Derby, East Haven, Middlebury, Milford, Orange, Oxford, Southbury and Woodbridge, in which no infestations were found.

Branford, Guilford, Madison and North Branford were scouted by State men and no infestations found. In the towns of Cheshire, Wallingford, Waterbury and Wolcott, the scouting was confined to the territory around last year's infestations because the scouting season had so far advanced by the time these towns were reached that it was impossible to complete them before the men had to begin spraying. Nothing was found in these towns.

FAIRFIELD COUNTY.

The work in Fairfield County was done by Federal men and consisted of scouting three towns, namely: Brookfield, New Fairfield and Sherman, no spraying being needed because no infestations were found.

STATISTICS OF INFESTATIONS

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Windham County—15 Towns Infested.					
Ashford[1]	0	0	0	0	0
Brooklyn	16	219	16	302	85
Canterbury	13	253	10	222	115
Chaplin	5	62	5	75	34
Eastford	0	0	0	0	43
Hampton	4	44	3	38	18
Killingly	44	2,114	63	820	761
Plainfield[2]	1	16	1	6	6
Pomfret[1]	0	0	0	0	59
Putnam[2]	5	50	3	45	60
Scotland	3	15	2	12	2
Sterling	20	376	15	178	118
Thompson[2]	18	485	15	168	1,311
Windham[2]	1	6	0	0	130
Woodstock[2]	70	1,085	57	705	1,352
	200	4,725	190	2,571	4,094

[1] Not scouted.
[2] Partially scouted.

STATISTICS OF INFESTATIONS—*Continued*

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
New London County—20 Towns Infested.					
Bozrah[1]	0	0	0	0	0
Colchester[1]	0	0	0	0	0
East Lyme	1	10	1	44	0
Franklin[1]	0	0	0	0	0
Griswold[2]	7	21	4	63	5
Groton	19	87	12	184	54
Lebanon[1]	0	0	0	0	0
Ledyard[1]	0	0	0	0	0
Lisbon[2]	4	33	3	37	20
Lyme[1]	0	0	0	0	0
Montville	1	14	0	0	0
New London	2	7	2	37	0
Norwich	5	31	3	25	6
No. Stonington[1]	0	0	0	0	0
Old Lyme[3]	0	0	0	0	0
Preston	6	195	5	66	19
Salem[1]	0	0	0	0	0
Sprague[1]	0	0	0	0	0
Stonington[1]	0	0	0	0	0
Voluntown[2]	3	11	1	12	0
Waterford	1	1 hatched	1	6	0
	49	410	32	474	104

[1] Not scouted.
[2] Partially scouted.
[3] Scouted only around infestations.

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Tolland County—14 Towns Infested.					
Andover[1]	0	0	0	0	0
Bolton[1]	0	0	0	0	0
Columbia[1]	0	0	0	0	0
Coventry	7	50	2	22	0
Ellington[2]	9	39	5	63	67
Hebron[1]	0	0	0	0	0
Mansfield	31	405	13	131	169
Somers[2]	3	26	2	13	5
Stafford[1]	0	0	0	0	0
Tolland[3]	0	0	0	0	0
Union[1]	0	0	0	0	0
Vernon[3]	0	0	0	0	0
Willington	22	215	11	101	77
	72	735	33	330	318

[1] Not scouted.
[2] Partially scouted.
[3] Scouted only around infestations.

STATISTICS OF INFESTATIONS—*Continued*

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Middlesex County—3 Towns Infested.					
Chester[1]	0	0	0	0	0
Clinton[1]	0	0	0	0	0
Cromwell	0	0	0	0	0
Durham[1]	0	0	0	0	0
East Hampton[1]	0	0	0	0	0
East Haddam[1]	0	0	0	0	0
Essex[1]	0	0	0	0	0
Haddam[1]	0	0	0	0	0
Killingworth[1]	0	0	0	0	0
Middletown[3]	1	1	0	0	0
Old Saybrook[3]	0	0	0	0	0
Portland[1]	0	0	0	0	0
Saybrook[1]	0	0	0	0	0
Westbrook[1]	0	0	0	0	0
	1	1	0	0	0

[1] Not scouted.
[2] Partially scouted.
[3] Scouted only around infestations.

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Hartford County—29 Towns Infested.					
Avon	1	12*	0	0	0
Berlin[2]	1	4	1	4	0
Bloomfield	6	67	6	150	1
Bristol	0	0	0	0	0
Burlington	2	23	2	68	1
Canton	0	0	0	0	0
East Granby	3	135	3	225	10
East Hartford	3	35	2	19	1
East Windsor	4	13	3	31	5
Enfield	4	15	4	37	4
Farmington	3	64	2	581	0
Glastonbury	0	0	0	0	0
Granby	5	159	3	75	11
Hartford	6	1,043	6	587	1,178
Hartland	5	29	4	285	5
Manchester	0	0	0	0	0
Marlborough[1]	0	0	0	0	0
Newington	0	0	0	0	0
New Britain	4	113	1	344	20
Plainville	0	0	0	0	0
Rocky Hill	1	137	1	88	21
Southington	1	5	0	0	0
South Windsor	2	24	2	10	4
Suffield	17	913	16	612	183
Simsbury	2	461	2	1,175	301
Wethersfield	4	626	3	75	0
West Hartford	0	0	0	0	0
Windsor	5	110	4	162	3
Windsor Locks	0	0	0	0	0
	79	3,988	65	4,528	1,748

[1] Not scouted.
[2] Partially scouted.

STATISTICS OF INFESTATIONS—*Continued*

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Litchfield County—13 Towns Infested.					
Bethlehem[4].......	0	0	0	0	0
Bridgewater[4]......	0	0	0	0	[illegible]
Barkhamsted......	3	9	1	30	50
Canaan[4]..........	0	0	0	0	0
Colebrook........	5	34	4	475	1
Cornwall[4].........	1	46	0	0	0
Goshen[1]...........	0	0	0	0	0
Harwinton........	0	0	0	0	0
Kent............	0	0	0	0	0
Litchfield[1]........	0	0	0	0	0
Morris[1]...........	0	0	0	0	0
New Hartford.....	1	4	1	60	0
New Milford[4].....	1	35	0	0	0
Norfolk[1]..........	0	0	0	0	0
North Canaan.....	0	0	0	0	0
Plymouth[3]........	0	0	0	0	0
Roxbury[4].........	0	0	0	0	0
Salisbury[4]........	2	8	0	0	0
Sharon[4]..........	0	0	0	0	0
Thomaston[1].......	0	0	0	0	0
Torrington[4].......	1	1*	0	0	0
Warren[4]..........	0	0	0	0	0
Watertown[4].......	0	0	0	0	0
Washington[4]......	0	0	0	0	0
Winchester.......	1	1*	0	0	0
Woodbury[4]........	0	0	0	0	0
	15	138	6	565	51

[1] Not scouted.
[2] Partially scouted.
[3] Scouted only around infestations.
[4] Scouted by Federal men.
*Old egg-cluster.

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
New Haven County—6 Towns Infested.					
Ansonia[4]..........	0	0	0	0	0
Beacon Falls[4]......	0	0	0	0	0
Bethany[4].........	0	0	0	0	0
Branford.........	0	0	0	0	0
Cheshire[3].........	0	0	0	0	0
Derby[4]...........	0	0	0	0	0
East Haven[4]......	0	0	0	0	0
Guilford..........	0	0	0	0	0
Hamden[4]..........	1	4	0	0	0
Madison..........	0	0	0	0	0
Meriden[1]..........	0	0	0	0	0
Middlebury[4]......	0	0	0	0	0
Milford[4]..........	0	0	0	0	0
New Haven[4]......	1	6	1	15	0
North Branford....	0	0	0	0	0

STATISTICS OF INFESTATIONS—*Concluded*

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
New Haven County—*Concluded*.					
North Haven[1]	0	0	0	0	0
Orange[4]	0	0	0	0	0
Oxford[4]	0	0	0	0	0
Seymour[4]	0	0	0	0	0
Southbury[4]	0	0	0	0	0
Wallingford[2]	0	0	0	0	0
Waterbury[2]	0	0	0	0	0
Wolcott[3]	0	0	0	0	0
Woodbridge[4]	0	0	0	0	0
	2	10	1	15	0

[1] Not scouted.
[2] Partially scouted.
[3] Scouted only around infestations.
[4] Scouted by Federal Men.

Towns	No. Infestations Found	No. Egg-Clusters Creosoted	No. Colonies Sprayed	No. Lbs. Poison Used	No. Larvae Killed
Fairfield County—No Towns Infested.					
Brookfield[4]	0	0	0	0	0
New Fairfield[4]	0	0	0	0	0
Sherman[4]	0	0	0	0	0
	0	0	0	0	0

[4] Scouted by Federal men.

SUMMARY OF STATISTICS

County	No. Towns Covered	No. Infes-tations	No. Egg-Clusters Destroyed	No. Infestations Sprayed	No. Lbs. Arsenate Used	No. Larvae Destroyed	No. Miles Roadway Scouted
Windham	13	200	4,725	190	2,571	4,094	659
New London	11	49	410	32	474	104	751
Tolland	7	72	735	33	330	318	391
Middlesex	3	1	1	0	0	0	50
Hartford	28	79	3,988	65	4,528	1,748	2,083
Litchfield	21	15	138	6	565	51	1,529
New Haven	22	2	10	1	15	0	1,337
Fairfield	3	0	0	0	0	0	175
	108	418	10,007	327	8,483	6,315	6,975

Thus it will be seen from the preceding table that work was done in 108 towns last year; that 418 gipsy moth infestations were found and 327 of them sprayed with lead arsenate, using 8,483 pounds or nearly four and one-fourth tons; that 10,007 egg-clusters were destroyed with creosote, and 6,315 larvae destroyed, besides those which may have been killed by the spray; also that 6,975 miles of roadway were scouted by the State men in this

work. In the towns scouted by the Federal men, no record was kept of the number of miles of roadway covered.

Financial Statement.

Receipts

Appropriation for biennial period ending June 30, 1925..... $100,000.00

Classified Expenditures for the Period Ending June 30, 1924

Salaries and Wages		$33,749.13	
Printing and Illustrations		48.33	
Postage		12.14	
Stationery		9.56	
Telegraph and Telephone		27.51	
Insurance (supplies including horse sprayer)		29.97	
Spraying Supplies		337.50	
Machinery, Tools and Supplies		345.04	
Express, Freight and Cartage		2.43	
Rental and Storage		761.57	
Automobiles: New	$1,384.00		
Insurance	467.45		
Repairs	874.15		
Supplies and Equipment	1,019.14		
Gasoline	1,610.81		
Oil	161.29		
		5,516.84	
Traveling Expenses		363.42	
Inspection of Imported Nursery Stock		498.09	
Heat and Light		96.48	
			$41,798.01
Balance			58,201.99
			$100,000.00

Parasites.

A somewhat detailed account of the different parasites and predatory insects which have been introduced into this country to attack the gipsy moth may be found in the 22nd Report of the State Entomologist, page 313 (Report of this Station for 1922, page 313) and need not here be repeated. In last year's report, page 265, a table shows the number of individuals of the Japanese egg parasite, *Schedius kuvanae* How., which were liberated in Connecticut in 1923. In 1924, there were liberated in Connecticut, 733,650 *Schedius kuvanae*, 243,000 of another egg parasite, *Anastatus bifasciatus* Fonsc., by State men, and 3,000 of a larval parasite, *Apanteles melanoscelus* Ratz., by Federal men. All of these parasites were reared at the Government parasite laboratory in Melrose Highlands, Mass., and furnished by Mr. Burgess for distribution in Connecticut. The following list, also furnished by Mr. Burgess, shows the number of each kind of parasite liberated, as well as the towns where they were planted:

GIPSY MOTH PARASITES LIBERATED IN CONNECTICUT
Year Ending June 30, 1924

	Schedius kuvanae	*Apanteles melanoscelus*	*Anastatus bifasciatus*
Brooklyn	56,000		
Canterbury	24,000		
Chaplin	24,000		
Colchester	4,000	500	
Columbia			11,000
Coventry			16,000
Eastford	96,000		
East Lyme	17,900		
East Windsor			11,000
Ellington			23,000
Enfield			4,000
Griswold	40,000		
Groton	20,000		7,000
Hampton	40,000		
Hartford			7,000
Lebanon	9,850	500	3,000
Ledyard	12,000	500	11,000
Lisbon	20,000		
Mansfield			23,000
Montville		500	1,000
New London	28,000		5,000
No. Stonington	4,000		24,000
Norwich	24,000		5,000
Old Lyme	12,000		
Plainfield	20,000		
Pomfret	60,000		
Preston	12,000		15,000
Rocky Hill			2,000
Scotland	32,000		
Simsbury			3,000
Somers	20,000		
South Windsor		500	7,000
Sprague	12,050		
Stafford	24,000		1,000
Sterling	17,850		
Stonington	28,000		
Suffield			17,000
Tolland			25,000
Vernon		500	
Voluntown	32,000		
Waterford	12,000		3,000
Wethersfield			4,000
Willington			15,000
Windham	32,000		
	733,650	3,000	243,000

Unquestionably much benefit has resulted from the combined attacks of the various parasites in the New England area, though the reduction in the numbers of the gipsy moth should not be attributed wholly to the action of parasites. It is the opinion of all men engaged in gipsy moth work, that creosoting of egg-clusters, spraying around infestations, and low temperature which

kills the eggs, are in some measure responsible for the decrease and together with the parasites, have brought about the present conditions. We hope that these gratifying conditions may continue but this is uncertain. It is probably true that there was less stripping in Massachusetts in 1924 than for many years, and as shown in the table on page 255, there were fewer colonies found in Windham County (the County longest continuously infested) than in 1917. These results must in part be accredited to the work of parasites, but it is still too early to abandon the field to them and appropriations should be continued for several years until they surely and permanently gain control of the gipsy moth.

Barrier Zone.

The plan of establishing a barrier or control zone, beyond which the gipsy moth will not be allowed to gain a foothold, was first advocated at a conference held in Albany, November 16, 1922. The proceedings of this conference were published as Agricultural Bulletin 148, Department of Farms and Markets of the State of New York, Albany, December, 1922, and the resolutions were included in the Report of this Station for 1922, page 325. Such a zone would be of no value unless extremely careful and thorough work is maintained in it, and this work is obviously the province of the Federal forces aided by those States west of the zone. However, the success of the plan depends principally upon appropriations adequate to carry it out. Nevertheless, to some extent its success will depend upon the degree of infestation near and east of the barrier zone, and here is where the New England States can help; for if the degree of infestation in western New England is slight, it will be much easier to maintain such a zone. If this area were intensely infested, and the condition favorable for windspread westward, infestations would certainly be carried into and beyond this zone, and it would be difficult and expensive to eradicate them.

This proposed barrier or control zone extends from the Canadian border on the north to Long Island Sound on the south, and includes Lake Champlain and the Hudson River with a strip of land east and west of both, until the Highlands are reached, when it is deflected toward the southeast, crossing Connecticut in a line from New Milford to New Haven. This zone is approximately thirty miles in width.

Quarantines.

As the Connecticut quarantine was last revised and became effective on July 20, 1922, and many additional towns have since been found infested and placed under Federal quarantine, it seemed best to make the State quarantine coincide with the Federal quarantine. Consequently, after due hearing as provided by Section 2106 of the General Statutes the following quarantine order was

issued as Bulletin of Immediate Information, No. 44, effective July 20, 1924:

STATE OF CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

QUARANTINE ORDER NO. 6

Concerning Gipsy Moth

In order to protect uninfested parts of Connecticut from danger of infestation by the gipsy moth, under authority given in Section 2106 of the General Statutes, the following regulations are hereby established.

1. The following towns are hereby placed under quarantine because of the gipsy moth:—

HARTFORD COUNTY:

Avon	Farmington	Plainville
Berlin	Glastonbury	Rocky Hill
Bloomfield	Granby	Simsbury
Bristol	Hartford	Southington
Burlington	Hartland	South Windsor
Canton	Manchester	Suffield
East Granby	Marlborough	West Hartford
East Hartford	New Britain	Wethersfield
East Windsor	Newington	Windsor
Enfield		Windsor Locks

LITCHFIELD COUNTY:

Barkhamsted	Harwinton	Plymouth
Canaan	Litchfield	Salisbury
Colebrook	New Hartford	Thomaston
Cornwall	Norfolk	Torrington
Goshen	North Canaan	Winchester

MIDDLESEX COUNTY:

Chester	East Hampton	Middletown
Clinton	Essex	Old Saybrook
Cromwell	Haddam	Portland
Durham	Killingworth	Saybrook
East Haddam	Middlefield	Westbrook

NEW HAVEN COUNTY:

Branford	Madison	Wallingford
Cheshire	Meriden	Waterbury
Guilford	North Branford	Wolcott
	North Haven	

NEW LONDON COUNTY:

Bozrah	Ledyard	Old Lyme
Colchester	Lisbon	Preston
East Lyme	Lyme	Salem
Franklin	Montville	Sprague
Griswold	New London	Stonington
Groton	North Stonington	Voluntown
Lebanon	Norwich	Waterford

TOLLAND COUNTY:

Andover	Ellington	Tolland
Bolton	Hebron	Union
Columbia	Mansfield	Vernon
Coventry	Somers	Willington
	Stafford	

WINDHAM COUNTY:

Ashford	Hampton	Scotland
Brooklyn	Killingly	Sterling
Canterbury	Plainfield	Thompson
Chaplin	Pomfret	Windham
Eastford	Putnam	Woodstock

These same towns have already been quarantined by the Federal Horticultural Board of the United States Department of Agriculture, and it shall be unlawful to remove from this quarantined area any woody nursery stock, lumber, cordwood, telegraph or telephone poles, railroad ties, or other forest plant products, unless the products shall have been inspected and certified by an authorized State or Federal inspector.

2. In view of possible future changes in the lines between the infested and non-infested areas of the State, the areas quarantined by the State shall conform to those quarantined by the United States Department of Agriculture: furthermore the regulations established by the Federal Horticultural Board of the United States Department of Agriculture for inter-state shipments, are hereby adopted for the inspection and certification of similar shipments from the quarantined area to points outside of this area within the State of Connecticut.

3. This order shall take effect from its date.

Dated July 20, 1924.

W. L. SLATE, JR.
Director, Connecticut Agricultural Experiment Station.

Approved:
CHARLES A. TEMPLETON,
Governor.

The quarantined area is shown on the accompanying map, and includes the following towns not covered in quarantine order No. 4: Cornwall and Litchfield in Litchfield County; Cheshire, Wallingford, Meriden, North Haven, Branford, North Branford, Guilford and Madison in New Haven County; Middlefield, Durham, Haddam, East Haddam, Killingworth, Clinton, Westbrook, Chester, Saybrook, Essex and Old Saybrook in Middlesex County; Lyme and Old Lyme in New London County.

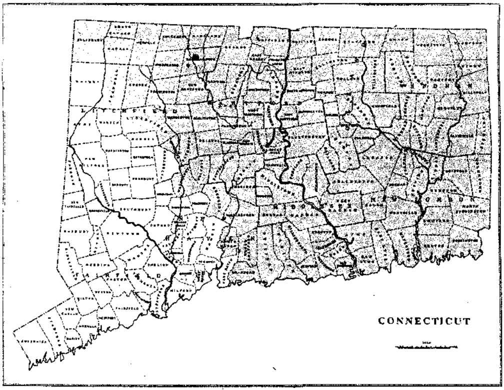

Figure 7. Map of Connecticut. The shaded portion represents the area quarantined on account of the gipsy moth.

All woody field grown nursery stock and forest products to be shipped from the quarantined area into the free area must be inspected by a State or Federal inspector and certified. All frequent shippers should procure a Federal map showing the quarantined area, the location and address of each Federal inspector and the area covered by him. These maps may be obtained from Mr. D. M. Rogers, 408 Atlantic Avenue, Boston, Mass.

An arrangement has been made by which inspections can be made by both State and Federal inspectors. Applications for inspection should be made to the nearest Federal Inspector or to:

D. M. Rogers, 408 Atlantic Ave., Boston, Mass., in charge of Federal inspection service; or

W. E. Britton, State Entomologist, Agricultural Experiment Station, New Haven, Conn., in charge of State inspection service.

Area Which Must Now Be Covered in Gipsy Moth Work.

The greatly increased area now under State and Federal Quarantine in Connecticut because of the gipsy moth includes 118 of the 169 towns of the State, though in some of these towns, especially in New Haven and Middlesex Counties near the coast, no gipsy moth infestations have ever been found. They were included in order to be on the safe side because there was not time to scout them all and it was uncertain whether or not they were infested. Some of these towns have since been scouted by State men and not found infested. The area and position of the quarantined territory may be shown in the following table:

Quarantined Territory.

County	No. Towns	No. Acres
Hartford........	29	477,749
Litchfield........	15	359,071
Middlesex........	15	249,377
New Haven......	10	187,083
New London.....	21	465,091
Tolland..........	13	266,617
Windham........	15	332,696
	118	2,337,684 = 3,652.6 square miles.

In addition to the quarantined territory listed above, the towns of New Milford, New Haven and Hamden were found infested by Federal scouts. These towns should be added to the areas given above.

Area to be Covered.

County	Town	Acres
Litchfield	New Milford	40,321
New Haven	New Haven	14,260
New Haven	Hamden	21,054
	Three towns	75,635
Quarantined area	118 towns	2,337,684
Total	121 towns	2,413,319 = 3,770.8 square miles.

Recommendations.

Considering the large increase in territory to be covered; that there has never been a sufficiently large appropriation to cover the infested territory in one season, and that it will now be difficult to get over it all in two seasons; that it is uncertain just how much can be done by the Federal forces in Connecticut: we have asked for an appropriation of $140,000.00 for the next two years. This is an increase of $40,000.00 over the last appropriation, and seems necessary if the work is to be done properly over the larger territory. The amount requested ($140,000.00) is equivalent to $37.13 per square mile, or five and eight-tenths cents (.058) per acre of ground which must be covered.

THE EUROPEAN CORN BORER IN CONNECTICUT.

W. E. BRITTON AND M. P. ZAPPE.

In the Report of this Station for 1923, page 277, is an account of three small infestations of the European corn borer, *Pyrausta nubilalis* Hubn., discovered along the Connecticut shore, and measures taken to eradicate them. During 1924, further work was done by Station men in co-operation with the Bureau of Entomology, U. S. Department of Agriculture. Federal scouts began early in the season and examined the entire coast region of the State from New York to Rhode Island, and extending inland for at least one mile. Then scouting was done around the principal seed corn growing districts in Milford, Orange and Wethersfield. Messrs. Zappe and Rogers of this office did supplementary scouting in Woodbridge, Wethersfield, Rocky Hill, Middletown and Salem, equivalent to 14 man days.

As a result of this scouting work, seven small infestations were found by the Federal men in the following locations: one in a corn field at Hillside Home, Bridgeport, in the northeastern portion of the city; one in gardens in New Haven, near the corner of Forbes and Townsend Avenues; one in a small corn field owned by Mr. Way on the eastern side of the town of Old Lyme; one in corn in East Lyme on land of Mr. E. W. Russell; one in corn in Groton on land of Mr. Frank Burnham, about three-fourths of a mile north of the town hall; and two in corn in Stonington, both in gardens near each other in the easterly portion of Mystic, one owned by Mr. Henry W. Morgan, 36 Church Street, and the other by Mr. Amos Hewitt, 26 School Street. Details will be given elsewhere under the several separate headings. After finding the infestations, the region immediately surrounding each was scouted two or three times to see if more larvae could be obtained.

For a portion of the time, the wages and expenses of the Federal scouts were paid from the insect pest appropriation granted to the Station for such work. In cleaning up around the seven infestations, both State and Federal men worked together. This arrangement made it possible to have the use of one of the Federal truck sprayers, designed for burning oil. The State paid for the oil, 5,485 gallons being used. For this purpose, fuel oil was purchased at eight cents per gallon. Burning operations were started on December 1, and completed December 12, 1924.

We desire here to express our appreciation and thanks to Messrs. L. H. Worthley, D. J. Caffrey, and their associates for the efficient and satisfactory co-operation and assistance which they have rendered to the State of Connecticut in this work.

Methods of Clean-Up Work.

The approved methods of clean-up work in and around small infestations of European corn borer, consist of burning all corn stalks, stubble and weeds. It is necessary to dig out the stubble which has been left after cutting the corn, and for this purpose a light mattock is a satisfactory tool. One blow will often dig the stubble from an entire hill, though in other cases it may require several blows, depending upon the number, size and distance apart of the stalks in the hill. On light soil where the corn is small, a potato hook is a handy tool for getting the stubble out of the ground. The roots should be shaken clean of soil as they will dry more readily, burn better and thus effect a saving in oil. Just before burning, the stubble should be raked into windrows or small piles. Shocks of corn may be burned just as they stand in the field.

The burning is greatly facilitated by using a power spray outfit so that the oil is under a pressure of between 150 and 200 pounds. It is conducted through a hose and thrown out through special triplex nozzles made for the purpose and placed on the end of a rod fitted with shut-off so that the operator may stop the flow when not needed (see Plate XXI, b.). The oil is ignited at the nozzles and makes a very hot fire. Corn stalks which are still rather green and contain a large amount of juice are soon heated to such a temperature that all larvae are killed. Dry stalks and weeds are entirely and almost immediately consumed. The entire field is gone over in this manner so that when completed, the field is black and nothing remains except a few charred pieces of corn stalks. All weeds around the margins of the field are also burned.

Bridgeport Infestation.

Hillside Home is the "poor farm" of Bridgeport and is situated on Bond Street just northeast of the city. The infestation was discovered by Federal scouts on July 24, 1924, when two larvae were found in smartweed in a corn field of about two acres near a spur railroad track. Later, October 23, one larva was found in this field in smartweed. The authors visited the place on this date in company with Mr. T. M. Cannon, of the Federal forces, to make plans for the clean-up. The corn had been harvested and put in the silo, and only some stalks, the high stubble and weeds remained. As we were short of help, we asked the Superintendent if he could have the stubble dug so that it would dry off before the time for burning, thinking that he would use some labor of the inmates for this purpose. He promised to do this, and we were greatly surprised when we went to burn, to find that he had tried to plow out the stubble. Some of it was partly plowed under, some loosened with large balls of earth, and most

of it was not disturbed at all. As there had been considerable rainy weather, the roots and stubble were not dry and were difficult to burn. Another corn field of about four acres across the spur railroad track and southeast of the infested field contained many weeds and was also burned over, making about six acres altogether burned over in the Bridgeport infestation. The burning was done on December 5, 8, 9, 10 and 11, and required 27 man days and 3,285 gallons of oil (see Plate XXI).

New Haven Infestation.

This infestation was in a small patch of sweet corn in the adjoining yards of Messrs. Edward W. Lovesey and E. Scandano, near the corner of Townsend and Forbes Avenues, commonly known as the Grannis Corners section. Two larvae were found in sweet corn August 25, 1924. A broom factory is located at 1180 Townsend Avenue and Mr. Lovesey's garden is directly back of the broom factory, though the land fronts upon Woodward Avenue. It is believed that the pest came here in imported broom corn as a number of burrows were found in the butts which had been trimmed off, and one dead larva was found in a burrow. There were also several small plots of sweet corn in adjacent yards altogether covering perhaps two acres. The corn had been cut, so the stubble was dug, and stalks, stubble and weeds burned. Some of the clippings from the broom factory had been dumped on Peat Meadow Road a short distance eastward, and we found exit holes of the borers in some of the clippings. These were all burned, together with all weeds in the vicinity, including those on the western side of the swamp. The stubble in the gardens was all dug in a half day by two men and the burning crew of six men completed the burning around the New Haven infestation in one day, using about 600 gallons of oil. The burning was done on December 4, 1924. (See Plates XXII and XXIII).

Old Lyme Infestation.

The infestation in Old Lyme was discovered on July 10, 1924, when one larva was found in a small corn field owned by Mr. Allen Way, beside the Four Mile River Road and about half-way between the shore road and the post road on the easterly side of the town. This field was surrounded on three sides by pasture and brush land and on the fourth side by the highway. Across the highway was more brush land. The field was about one-half acre in extent, and the corn had been cut and fed to cattle. The stubble was dug in a day by two men. Then it was raked together in a large pile, and this pile together with weeds all around the field was burned in one-half day by a crew of six men, using only about 100 gallons of oil, on December 12, 1924.

East Lyme Infestation.

This infestation was not discovered until November 15, 1924, when Messrs. Lantz and Habberly, Federal scouts, found four larvae in corn beside the west-bound railroad tracks, near the underpass close to the Crescent Beach railroad station. This corn was on Fairhaven Road and was owned by Mr. E. W. Russell. An adjacent field owned by Mr. Stone was near the original infestation and was also burned over. Mr. Russell had two fields:—one of two acres of late planted corn, grown as fodder for cows, another of about one acre of early sweet corn, the stalks of which had been cut and fed to cows. The corn in the larger field had been cut and placed in shocks.

Mr. Stone's corn was late sweet corn, about a half-acre in extent and was growing between the rows of young apple trees. The corn had not been cut, so had to be pulled and moved away from the apple trees before burning. There were also many large weeds which were burned.

In Mr. Russell's fields, the stubble had to be dug and raked together. Five men spent two days preparing these fields for burning and six men did the burning on December 2, 3 and 12 in two and one-half days, using 1,300 gallons of oil.

Groton Infestation.

At this infestation, Federal scouts discovered seven larvae in sweet corn, July 28, 1924, on land owned by Mr. Frank J. Burnham on North Road, about three-fourths of a mile north of the Groton Town Hall. The corn was evidently fed to livestock so that there was little to burn, but on December 1, the bits of stalks as well as the weeds on the land and especially around the edge of a swamp were burned, using 100 gallons of oil.

Stonington Infestations.

Both infestations in Stonington were discovered by Federal scouts on August 4-5, 1924, and these were both on the easterly side of the village of Mystic. One was in the garden of Mr. Henry W. Morgan, 36 Church Street, where two larvae and six pupae were found in corn, and the other was in the garden of Mr. Amos G. Hewitt, 26 School Street, where also two larvae and six pupae were found in the stalks of sweet corn.

The stubble and large weeds in both gardens were dug in one day by two men and left about two weeks to dry. The burning was done on December 1, in about one-half day, and 100 gallons of oil were used. Some corn and weeds in a yard adjoining Mr. Hewitt's were burned at the same time, altogether covering perhaps an acre of ground in Stonington.

Summary of Clean-Up Work.

The clean-up work may be summarized in the following table:

Towns Infested	No. Acres	Time Digging Stubble-Days	Time Burning Man Days	Date of Burning	Oil Used Gallons
Stonington.......	1	2	3	Dec. 1	100
Groton..........	1	0	3	Dec. 1	100
East Lyme.......	3.5	10	15	Dec. 2, 3, 12	1,300
Old Lyme........	.5	2	3	Dec. 12	100
New Haven......	2	1	6	Dec. 4	600
Bridgeport.......	6	0	27	Dec. 5, 8, 9, 10, 11	3,285
Total........	14	15	57		5,485

Repeal of Quarantine.

At a conference held in Washington, D. C., April 28-30, 1924, at which many officials of the eastern states, Federal Horticultural Board, and United States Department of Agriculture were present, the whole subject of quarantines was considered and recommendations adopted. It was the sentiment of the conference that quarantines should not be established by states against other states when action on the subject has been taken by the Federal Horticultural Board fully covering the matter. The Federal quarantines are generally considered to control inter-state shipments and not those from one point to another within the bounds of a state.

The Connecticut quarantine against the European corn borer was first established, and became effective September 20, 1918. This was revised to include additional territory found to be infested, and Quarantine Order No. 3 was issued, effective June 1, 1920. A further revision was made in Quarantine Order No. 5, effective June 1, 1923, relating to this insect.

Up to this time, these three quarantine orders issued because of the European corn borer, placed restrictions only on shipments entering Connecticut from the infested territory in eastern New England, New York, Pennsylvania, Ohio and Michigan, as no infested territory had been discovered in Connecticut, and could not, therefore, be placed under quarantine. It was evident that our quarantine would be regarded as a restriction placed by a state upon inter-state commerce, and would probably be declared unconstitutional if it came to a test. Moreover, the State of Connecticut had been adequately protected by the Federal quarantine. Consequently the following order was issued:

STATE OF CONNECTICUT

OFFICE OF

AGRICULTURAL EXPERIMENT STATION.

NEW HAVEN, CONN.

QUARANTINE ORDER No. 7.

Effective July 1, 1924.

Whereas, Quarantine Order No. 5, issued from this Office effective June 1, 1923, on account of the European corn borer, *Pyrausta nubilalis* Hubner, prohibited certain portions of corn and other plants from infested regions of Maine, New Hampshire, Massachusetts, Rhode Island, New York, Pennsylvania, Ohio and Michigan, from being brought into Connecticut, the following memoranda may be recorded:

1. That all regions where this insect now exists are under Federal Quarantine.
2. That Connecticut is therefore duly protected by Federal Quarantine.
3. That no portion of Connecticut has been placed under Federal Quarantine on account of the European corn borer.
4. That it was the voice of the quarantine conference at Washington, D. C., April 28-30, 1924, that States should not establish quarantines against other States when the subject has been fully covered by Federal action.
5. That the Federal Quarantine takes precedence in such cases where there is a seeming conflict, and the State quarantine is null and void.
6. That the present case in no way prejudices future action regarding an intrastate quarantine, when it has been found that a portion of the State has become infested.

The present European corn borer regulations (Quarantine Order No. 5) are hereby repealed.

This order shall take effect July 1, 1924.

W. L. SLATE, Jr., Director,
Connecticut Agricultural Experiment Station.

Approved:

CHARLES A. TEMPLETON, Governor.

FURTHER WORK NEXT SEASON.

It will be necessary to do considerable scouting work next year, around these infestations to see if any traces of the pest can be found. Probably it will also be best to rescout the same or similar territory each year to make sure that the European corn borer has not established itself. Various sections of the State will also need to be scouted where there may be danger of infestation or to protect some local vegetable or seed growing industry.

Anticipating work of this nature, an item of $5,000 was placed in the budget of the Station for the next fiscal period, to defray the cost of work against the European corn borer. At this writing it seems doubtful if this will be enough, as more than half as much has already been expended against this insect in the single season of 1924.

INSECTS FOUND ON TWIGS OF FRUIT TREES.

In February, 1924, the officers of the Connecticut Pomological Society requested that the Station give additional services to fruit grower members of the Society by furnishing definite and timely information and advice regarding spray treatment for the various insects and diseases found in Connecticut orchards. After a full consideration of the matter, it was decided to attempt this project and of course the work naturally belongs in the Departments of Entomology and Botany.

It was decided that we needed more data on exact conditions in the various orchards, and that some data could be gathered by personal visits, but that orchardists should send in suspected twigs for examination and report. Messrs. Zappe, Garman and Stoddard visited several orchards, examined the trees for pests, made notes, and in some cases brought back twigs for microscopic examination. Orchardists also cut and sent twigs which were examined for insects in the laboratory by Dr. Philip Garman. In this manner, twigs from 18 different apple orchards were given this laboratory examination and the results afterwards reported to the owners or managers. The result of this examination as regards insects on apple is shown in the following table:

INSECT INHABITANTS

EXAMINED MARCH

H—Heavy, M—Medium, L—Light.

Name and Locality	Date	European red mite eggs	Oyster-shell scale	Woolly aphid galls
Hale Orchard Co., Seymour	Mar. 7	Baldwin—H. McIntosh—L.	Baldwin—H.	Baldwin—L. Greening—L.
C. L. Gold, West Cornwall	10	0	McIntosh—L.	McIntosh
W. F. Platt, Milford	10	Baldwin—L. McIntosh—L. Fall Pippin—L. Greening—L.	Greening—L.	Greening—L. Fall Pippin—L.
C. E. Lyman Estate, Middlefield	11	Baldwin—L. McIntosh—L. No. Spy—L. Fameuse—L. Ben Davis—L.	0	Baldwin—L. McIntosh—L. Fameuse—L. Ben Davis—L.
E. Rogers & Son, Southington	12	Baldwin—H. McIntosh—L.	0	Baldwin—L. McIntosh—L.
E. M. Ives, Meriden	12	Baldwin—L. McIntosh—L.	0	McIntosh—L.
Frank N. Platt, Milford	14	Baldwin—L. Other var.—L.	0	Baldwin—L. Other var.—L.
L. H. Warncke & Son, Cannondale	15	Baldwin—M. Greening—L.	Greening—L.	Baldwin—L. Greening—L.
Conn. Agr. College, Storrs	17	Baldwin—L. McIntosh—L. Fall Pippin—M. Winesap—M.	0	Baldwin
J. H. Hale Co., So. Glastonbury	18	Var. ?—L.	0	Var. ?—L.
L. C. Root & Son, Farmington	19	Baldwin—H. McIntosh—M. Fall Pippin—L.	0	Baldwin McIntosh
Mountain View Orchard Co., Hazardville	20	Baldwin—H. Greening—L.	0	Greening—L.
A. F. Greene, Middlebury	22	McIntosh—L. Other var.—L.	0	Other var.—L.
Walter H. Baldwin, Cheshire	22	0	0	Baldwin—L. Wagener—L. Sutton—L.
Conyers Farm, Greenwich	25	McIntosh—L. Gravenstein—L.	0	McIntosh—L. Gravenstein—M. King—L.
Conn. Valley Orchard Co., Deep River	27	0	0	King—L. Russet—L.
Gulley & Son, Rockville	Apr. 1	Fall Pippin—L.	0	McIntosh—L. Fall Pippin—L.
S. A. Smith & Son, Clintonville	14	Delicious—L.	0	McIntosh—L.

OF APPLE TWIGS.

AND APRIL, 1924

Bark Miner Tunnels	Rosy aphid eggs	Buffalo tree hopper eggs	Ormenis sp. eggs	Tent-caterpillar egg-masses	Name
Baldwin Delicious	0	0	Greening*	0	(Hale)
0	0	0	0	0	(Gold)
McIntosh Fall Pippin	Baldwin—L. McIntosh—L. Fall Pippin—L. Greening—L.	0	0	0	(Platt)
Baldwin No. Spy	McIntosh	0	0	1 on Fameuse	(Lyman)
Baldwin	0	0	0	0	(Rogers)
McIntosh Other vars.	0	0	0	0	(Ives)
Baldwin Other var.	Baldwin Other var.	0	Other var.	0	(Platt)
0	Greening—L.	Greening	0	1 on Greening	(Warncke)
0	0	No. Spy	0	0	(College)
Var. ?	Var. ?—L.	Var. ?—L.	Var. ?—L.	0	(Hale)
Baldwin McIntosh Fall Pippin	0	0	0	0	(Root)
0	0	0	0	0	(Mt. View)
McIntosh Other var.	McIntosh	0	0	1 on McIntosh	(Greene)
0	0	McIntosh	0	0	(Baldwin)
0	0	0	McIntosh	0	(Conyers)
King Russet	0	0	0	0	(Conn. Valley)
McIntosh Gravenstein	Wagener—M. Fall Pippin—L.	0	Wagener Gravenstein	0	(Gulley)
0	0	McIntosh	McIntosh Delicious	0	(Smith)

* Also a few cigar cases of *Coleophora.*

In addition to the apple twigs examined, some peach and pear twigs were also received and examined. Thus Elberta peach twigs from the Hale Orchard Co., Seymour; peach twigs from E. Rogers & Son, Southington; Elberta from L. H. Warncke & Son, Cannondale; peach twigs from the Connecticut Agricultural College, Storrs; Elberta from the Mountain View Orchard Co., Hazardville; Hiley from Conyers Farm, Greenwich; Stump, Elberta and another variety from the Connecticut Valley Orchard Co., Deep River; and Mountain Rose, Belle of Georgia, Carman and Elberta from Gulley & Son, Rockville, exhibited no pests. Elberta from W. F. Platt & Son, Milford, from the C. E. Lyman Estate, Middlefield, and Hale, Elberta and Greensboro from L. C. Root & Son, Farmington, showed eggs of the European red mite, *Paratetranychus pilosus* C. & F., though the infestations were light in all cases. One of the peach twigs from Milford showed evidence, though not unmistakable proof, that it had been attacked by the Oriental peach moth, *Laspeyresia molesta* Busck.

Pear twigs from the Connecticut Agricultural College had been infested with pear psylla, *Psylla pyricola* Foerster, and twigs from Conyers Farm, Greenwich, contained some insect eggs not familiar to us, possibly laid by Membracids or treehoppers. Twigs from the J. H. Hale Orchard Co., were marked with scars caused by hail during 1923.

In case of woolly aphid, *Eriosoma lanigerum* Hausm., galls on the twigs and the waxy exudation were the only evidence. In all other cases except the case bearer, all insects on the apple twigs were in the egg stage.

It is rather surprising and withal somewhat significant that in examining these twigs from 18 different orchards from three-fourths of the Counties of the State (only Windham and New London not being represented) that not a single San José scale, *Aspidiotus perniciosus* Comst., was found.

DUSTING VERSUS SPRAYING.

Season of 1924.

M. P. Zappe and E. M. Stoddard.

The experiments to determine the relative value of dusting and spraying which were begun in 1920 were continued in 1924. While it has been demonstrated that the best grade of apples are grown by spraying, there is considerable value in dusting, especially in dry years. In addition to the plots receiving either spray or dust, we have had during 1924 plots which were both sprayed and dusted.

The results of previous years work have been published as follows: Report for 1920, page 168, results of 1920; Bulletin 235, results of 1921; Bulletin 245, results of 1922; Report for 1923, page 267, results of 1923.

Orchards Under Experiment.

The two orchards used in these experiments were both used in former experiments. One was located in Milford, the orchard of F. N. Platt, and contains 285 trees about 20 years old. The other was the old orchard at the Experiment Station Farm at Mount Carmel. This orchard is about 48 years old and consists of 40 trees, mostly Baldwins and Greenings.

Acknowledgments.

The writers are indebted to Mr. Frank N. Platt of Milford for the use of his orchard, power sprayer and assistance in conducting these experiments, and also to Messrs. George Graham, J. L. Rogers, B. H. Walden, P. Garman, T. F. Cronin and H. F. Bender, who helped in the applications of treatments and in harvesting and scoring the fruit.

Apparatus Used.

The spray outfit was the same as used in the preceding experiments, a 200 gallon Friend power sprayer, carrying two lines of hose with rods and nozzles at about 200 pounds pressure. The duster was a 1923 model Niagara power outfit mounted on an automobile truck.

Spraying and Dusting Materials Used.

Liquid Spray.

Lead arsenate	3 pounds
Dry lime-sulphur	6 pounds
Casein spreader	1 pound
Nicotine sulphate	¾ pint
Water	100 gallons

Sulphur-Lead Arsenate Dust.

Sulphur	90%
Lead Arsenate	10%

Green Copper Dust.

Metallic Copper	6%
Metallic Arsenic	3%

Blue Copper Dust.

Metallic Copper	3.74%
Metallic Arsenic	1.76%

Number and Time of Applications.

Six applications of spray and dust were made in the Platt orchard at Milford, beginning with the prepink treatment on McIn-

tosh only. The owner gave the entire orchard an oil spray when the buds were beginning to open. In this orchard, leafhoppers were very plentiful on the dusted plots so these plots were given an application of nicotine dust on June 2.

Prepink treatment (McIntosh only)	May 1
*Pink treatment	May 7–8
*Calyx treatment	May 28
*First after calyx treatment	June 11–12
Second after calyx treatment	July 8–9
Third after calyx treatment	August 6

Plots.

The Platt orchard in Milford was divided into seven plots as shown in Table I. The first three rows (A, B and C) were sprayed; the next three (D, E and F) were dusted with 90-10 sulphur-arsenate dust. The north half of rows G, H and I was treated with green copper dust, while the south half was treated with blue copper dust. The north half of rows J, K and L was treated as follows: prepink, pink and calyx, with spray; first and second after calyx, with 90-10 dust; third after calyx, with spray (combination No. II). The south half of the same rows was treated as follows: prepink and pink, sprayed; calyx and three other applications were of 90-10 dust (combination No. I). Rows M and N were left untreated for a check against the treated plots.

Table 1.

Treatments	Plot 1 Rows ABC	Plot 2 Rows DEF	Plot 3 Rows No. half GHI	Plot 4 Rows So. half GHI	Plot 5 Rows No. half JKL	Plot 6 Rows So. half JKL	Plot 7 Rows MN	
Prepink	Spray	90–10 dust	Green copper dust	Blue copper dust	Spray	Spray	Check	McIntosh variety treated
Pink	Spray	*Dust*	*Dust*	*Dust*	Spray	Spray	Check	All varieties
Calyx	Spray	Dust	Dust	Dust	Spray	90–10 dust	Check	All varieties
1st after calyx	Spray	Dust	Dust	Dust	90–10 dust	90–10 dust	Check	All varieties
2d after calyx	Spray	Dust	Dust	Dust	90–10 dust	90–10 dust	Check	All varieties
3d after calyx	Spray	Dust	Dust	Dust	Spray	90–10 dust	Check	All varieties

Plot 1—Sprayed
Plot 2—90–10 sulphur-arsenate dust
Plot 3—Green copper dust
Plot 4—Blue copper dust
Plot 5—Combination Plot No. 2
Plot 6—Combination Plot No. 1
Plot 7—Not treated—checks.

Checks on all varieties have had no treatment in last four years.

* Nicotine in liquid spray.

TABLE 2.

RESULTS OF TREATMENTS ON McINTOSH.

MILFORD ORCHARD.

	Spray	90–10 Sulphur-arsenate Dust	Green Copper Dust	Blue Copper Dust	Combination 1 South	Combination 2 North	Check
Good	84.3	74.4	68.9	60.5	52.4	60.0	4.4
Scab	6.3	14.4	15.0	24.9	26.5	25.4	71.5
Aphis	2.95	5.5	6.03	3.64	7.3	7.4	10.2
Red bug	3.62	1.9	6.9	6.69	8.94	7.16	20.3
Codling moth	.43	.56	.55	.81	1.38	.44	4.01
Curculio	1.26	1.66	1.66	3.1	6.6	4.01	37.0
Other chewing insects	1.37	2.58	2.72	3.25	3.76	2.02	3.71
Sooty blotch	0	.02	0	Trace	Trace	0	Trace

DISCUSSION OF RESULTS.

The sprayed plot gave the highest percentage of good fruit and the 90-10 dust plot came next. The copper dusts were not so good as the 90-10 sulphur-arsenate dust in control of scab. Neither of the combination treatments were as efficient as the spray, the sulphur or the green copper dusts, combination No. 2 being on a par with the poorest of the copper dusts. The plots receiving the combination treatments were at the lower edge of the orchard just east of a woodlot and the trees were in a copper dust plot last year where there was much scab, which may possibly account for the large amount of scab present this season.

TABLE 3.

RESULTS OF TREATMENTS ON BALDWIN.

MILFORD ORCHARD.

	Spray	90–10 Sulphur-arsenate Dust	Green Copper Dust	Blue Copper Dust	Combination 1 South	Combination 2 North	Check
Good	85.9	87.2	86.5	86.5	79.0	85.5	No fruit
Aphis	9.65	8.2	8.5	6.03	15.4	8.1	No fruit
Red bug	2.2	.49	.2	.44	.6	1.42	No fruit
Codling moth	.01	.52	.68	1.88	1.53	.35	No fruit
Curculio	.69	1.1	1.71	.89	1.47	2.2	No fruit
Other chewing insects	1.7	2.4	2.82	4.55	2.4	2.4	No fruit
Scab	0	0	0	Trace	0	0	No fruit
Sooty blotch	0	0	.18	0	0	.14	No fruit

DISCUSSION OF RESULTS.

There is very little difference in any of the plots of this variety. Combination plot number one was lower in the percentage of

good fruit than the other plots; this was caused by a higher percentage of injury by aphids. The Baldwin trees in the check rows bore no fruit.

TABLE 4.

RESULTS OF TREATMENTS ON GREENING.

MILFORD ORCHARD.

	Spray	90–10 Sulphur-arsenate Dust	Green Copper Dust	Blue Copper Dust	Combination 1 South	Combination 2 North	Check
Good	75.0	81.0	68.4	68.4	70.0	62.2	10.7
Aphis	22.3	12.9	23.5	23.9	21.0	30.8	5.9
Red bug	.66	.66	1.17	1.17	2.6	6.0	62.5
Codling moth	.63	1.19	1.29	1.05	1.65	.62	4.99
Curculio	.78	2.18	2.62	3.06	2.9	5.7	21.9
Other chewing insects	.726	1.6	1.92	2.82	1.7	2.52	3.44
Scab	.21	.66	2.2	1.56	.95	2.76	27.9
Sooty blotch				.37		1.99	6.83

DISCUSSION OF RESULTS.

In the Greening plots the sulphur-arsenate dust was a little better than the liquid spray. The copper dusts averaged a little more good fruit than the plots receiving a combination treatment. In the check plot the fruit was badly deformed by red bugs and aphids and most of this injury was scored as red bug work, but a good share of it was undoubtedly caused by aphids; probably much more than the figures show. The variation in amount and control of scab was so small between the different treatments that a choice can hardly be made as can easily be done on the McIntosh.

TABLE 5.

RESULTS OF TREATMENTS ON GRAVENSTEIN.

MILFORD ORCHARD.

	Spray	90–10 Sulphur-arsenate Dust	Blue Copper Dust	Combination 1 South	Check
Good	66.2	74.6	75.9	75.3	37.5
Aphis	29.8	22.2	17.5	18.3	31.9
Red bug	.518	1.02	.4	.38	2.74
Codling moth	.28	.05	.23	.31	.98
Curculio	1.8	1.4	1.71	2.78	22.07
Other insects	.97	.9	1.44	1.67	3.82
Scab	.61	2.35	2.99	1.05	13.34
Sooty blotch			.08	.105	2.53
Fruit speck			.13	.005	.239

Discussion of Results.

The Gravenstein trees are located on only one side of the orchard: therefore there were none in the green copper plot nor in the combination plot number two. The sprayed plot gave the lowest percentage of good fruit because the aphis injury was high on the fruit of this plot. Between the other three treatments there is very little choice, as they produced about the same amount of good fruit. In amount of scab, the sprayed plot was a little lower than the others, the highest percentage except for the check being in the blue copper dust plot. The blue copper dust and combination No. 1 plots showed a small percentage of sooty blotch and fruit speck.

Mount Carmel Orchard.

The old orchard at the Experiment Station Farm was divided into two plots. The first application in this orchard was the calyx treatment followed by three others. As there were no varieties in this orchard that were very susceptible to scab, we felt that the prepink and pink treatments could be omitted.

Treatments	Plot 1	Plot 2	Dates of Applications
Calyx..........	Spray	90–10 Dust	May 29
1st after calyx....	Spray	Spray	June 13
2d after calyx....	90–10 Dust	Spray	July 9
3d after calyx....	90–10 Dust	Spray	August 7

The spray applications in this orchard were applied with an Arlington X. L. Sprayer, using two lines of hose with two nozzles at each rod. The duster was the same as used in the other orchard.

The applications of dust in both orchards were usually put on *either in late afternoon or in morning before dew had dried or* wind had begun to blow.

The check trees bore no fruit so no data was obtained.

Table 6.

Results of Treatments on Baldwin.

Mount Carmel Orchard.

	Plot 1 16 trees	Plot 2 4 trees
Good....................	81.1	67.4
Aphis....................	11.6	22.1
Red bug..................	.03	.16
Codling moth............	.56	1.02
Curculio.................	5.27	8.17
Other chewing insects.....	1.66	3.5
Scab....................	.04	.03

Discussion of Results.

Plot 1 having first two treatments of liquid spray gave better control of all pests and therefore produced a higher percentage of perfect fruit.

Table 7.

Results of Treatments on Greening.

Mount Carmel Orchard.

	Plot 1 6 trees	Plot 2 7 trees
Good	62.56	54.38
Aphis	14.27	20.72
Red bug	.12	.14
Codling moth	1.66	1.3
Curculio	19.3	22.65
Other chewing insects	2.78	4.55
Scab	4.68	2.84
Sooty blotch		.01
Cedar rust		.11

Discussion of Results.

As in the Balwin plot in this orchard, the treatment on Plot 1 gave a higher percentage of good fruit than Plot 2. The percentage of aphid and curculio injury was much higher on this variety than on the Baldwin. Scab injury is also a little more evident.

Summary.

On the McIntosh, chiefly due to scab control, the liquid spray was 10 to 30 per cent. better than any of the other treatments, with 90-10 sulphur-arsenate dust a close second. The application of nicotine in the spray gave very good control of leafhoppers but the one application of nicotine dust gave in most cases better control of aphis than did the three applications of nicotine spray. This is shown by the fact that in every case where dust gave more perfect fruit than spray, the difference was due to aphis control.

On Baldwin, Greening and Gravenstein, aphids were the controlling factor in the production of perfect fruit. Where aphids were controlled by the treatment or were absent for some other reason, the per cent. of perfect fruit was correspondingly high and vice versa, a high per cent. of aphids lowered the per cent. of perfect fruit. Other insects were controlled about equally well by all the treatments and due to the dryness of the season after June 1, fungi did not develop sufficiently to be important.

At the Mount Carmel orchard, the combination plot (having the calyx and the first treatment after the calyx with liquid spray) was the best on both Baldwin and Greening. Here as in the other orchard aphids were responsible for the largest amount of injury. Curculio ranks next in amount of injury in this orchard.

SUMMARY OF FIVE YEARS WORK ON SPRAYING AND DUSTING.

M. P. Zappe and E. M. Stoddard.

In order to show the relative merits of spraying and dusting as determined by the results of our experiments during the years 1920 to 1924 inclusive, we here present a summary in which are brought out the points that seem to have been demonstrated in these particular experiments. We have included some other interesting features in regard to the occurrence and control of insect and fungous pests.

In the preparation of these data we have scored 564,675 apples, chiefly of four varieties, McIntosh, Greening, Gravenstein and Baldwin, in four different orchards in the vicinity of New Haven.

The following table gives the average results in per cent. for all the spraying, dusting and checks on all varieties for the five years indicated above. In this table "other fungi" includes sooty blotch, fruit speck, rust, black rot and bitter rot. "Other chewing insects" includes the various chewing insects other than are listed which attack the fruit of apples.

Treatment	Good	Scab	Other Fungi	Aphis	Red Bug	Curculio	Codling Moth	Other chewing insects
	%	%	%	%	%	%	%	%
Spray...	68.6	14.7	6.05	10.0	1.3	17.7	.94	1.8
Dust....	41.4	30.2	28.4	10.7	2.6	21.8	1.4	4.7
Check...	12.2	40.5	34.8	9.7	12.8	48.6	11.7	9.8

It would seem from these figures that dusting is practically as good as spraying for the control of red bug, curculio, codling moth, and other chewing insects, but in the control of fungi there is a wide variation in favor of the spraying. Aphids have not been controlled by either treatment, in fact the checks show the least amount of injury. It is evident that aphids and curculio cause the greatest amount of insect injury on treated trees and are the most difficult to control.

Scab took the largest toll of all the fungi, with sooty blotch and fruit speck ranking next, these latter making up the greater part of the injuries listed in the table as "other fungi." Rust, black rot and bitter rot are so rare as to be negligible on the varieties included in the orchards in this study.

In the study of the data it was found that scab was the least prevalent in 1920, which year had the largest amount of rain of all of the five years, and in 1921-22-23-24 which had normal rainfall or less than normal, the per cent. of scab was higher by 50 to 70%. These computations were made on the data from check trees which represent the actual amount of scab present in the orchard, and were not influenced by variations of treatment. A study of the weather conditions during April, May and June of

these years showed that in 1920 the periods of high humidity were very short, the per cent. of humidity dropping immediately and sharply after a rain, while in the other years the humidity dropped slowly after rains, sometimes lagging over three or four days, and very light rains were often accompanied by high and sustained rises in humidity.

Further study will be necessary to establish this apparent relation to per cent. of humidity rather than actual rainfall, but it would seem that better results from spraying would follow if it be done before or during sustained periods of high humidity rather than before rains. It is our belief that a close study of the weather conditions is a safer guide for the orchardist to follow than information as to time and duration of spore discharge, because it is safe to suppose that sufficient spores will always be discharged to cause a damaging amount of infection if weather conditions are suitable for such infection and if the trees are protected during optimum periods for infection the desired control will be obtained. Inability to predict these conditions accurately will necessitate spraying a certain number of times as insurance, timing them as near as possible to give maximum protection.

Our data show that McIntosh is the most severely attacked by scab of the varieties used in the experiments, but the amount of injury from all other insect and fungous pests is considerably less than on the other varieties. Baldwin is the least susceptible to scab but much more susceptible to sooty blotch and fruit speck, and in most cases shows more curculio injury. Gravenstein is most severely injured by aphids of all the varieties observed.

TESTS OF INSECTICIDES FOR THE CONTROL OF THE ASIATIC BEETLE.

Anomala orientalis Waterhouse.

M. P. Zappe and P. Garman.

This insect has caused considerable injury to lawns in the western part of the City of New Haven, in the vicinity where the adults of this insect were first collected on July 16, 1920. In some cases sections of lawns equivalent to 60 square yards and smaller have been ruined by the larvae or grubs, as they are commonly called, which devoured the roots of the grass. Where the infestation is heavy, the turf may be rolled up like a carpet. Many of the property owners have spaded up the infested sections, collected, and killed all the grubs they could find, afterwards reseeding their lawns. During the summer of 1924, tests of several insectides and methods of their application were made to determine which of these are the most practicable and efficient in controlling this insect in the larval stage in lawns. So far as we know, this pest has not been troublesome in gardens, with

the exception of one case where a few grubs were found in a strawberry bed near a badly infested lawn.

Previous accounts of this insect in Connecticut have been published in the Report of this Station for 1922, page 345, and for 1923, page 291.

Calcium Cyanide.

This material was used on lawns in several tests at strengths varying, from four to six ounces per square yard. It is a coarse dust containing from 40 to 50 per cent. of calcium cyanide, and is very poisonous, not only when taken internally, but when the gas is inhaled. The soil where all tests were made was a type of light sandy loam.

Two plots were laid out on an infested lawn; one containing 20 square yards was treated with calcium cyanide at the rate of four ounces to the square yard, the other containing 60 square yards was given a dosage of six ounces per square yard. The cyanide dust was applied to the lawn as evenly as possible with a hand fertilizer drill, after which the ground was thoroughly wet down with a garden hose to wash the cyanide into the soil. (See plates XXIV, b and XXV, a).

Before applying the cyanide, a square foot of soil was dug up and all larvae were counted. There were 63 larvae in this square foot of soil, most of them being in the upper three inches among the grass roots, although a few were found six inches deep. Other sections were also dug, and found to be similarly infested.

Prior to our treatment of this lawn, the owner had spaded part of it and what sod was left had been turned under, so that it was buried four or five inches deep. The treatment was applied on May 14. On May 19, many of the grubs were dead in both plots, but in that portion of the lawn which had been spaded, before treatment, most of the live grubs were in the sod which had been turned under, and were too deep to be killed by the cyanide.

A good kill was obtained on that portion of lawn which had not been spaded, and practically all of the dead larvae were in the first two inches of soil; below this depth there were quite a number of living ones. All grass on the treated portion of lawn was badly burned by the cyanide.

Both plots were treated as one on May 31, with calcium cyanide, using about five ounces per square yard. This time the ground was spaded after the application, then immediately treated again, and watered thoroughly. On this date the wind was quite strong and blew some of the cyanide dust upon rose bushes, Spiraea and Weigela. Nearly all the leaves on the rose bushes were so badly injured that they dropped off, and the Spiraea and Weigela were also injured, though not so badly as the roses. The

roses were not killed, as they produced a new set of leaves in a short time.

A few days later an examination of this plot was made and it was found that about a 100 per cent. kill had been obtained. On May 19, several small wire cages containing three larvae and a small piece of sod each, were buried in small holes in the ground at the following depths from the surface; one hole with two cages, one three inches, the other six inches deep; another hole with cages at five inches and another seven to nine inches deep; and one hole with cage four inches deep. One ounce of cyanide was then placed in a hole eight inches deep and six inches from the holes containing the buried cages of larvae, and covered with soil.

An examination made a week later gave the following result:

Depth Buried Inches	No. Alive	No. Dead
3	3	0
5	2	1
6	3	0
7 to 9	2	1
4	3	Not treated

On another lawn, a plot one yard square was selected and holes made with a crowbar about six inches deep and 12 inches apart; each hole was dosed with one-third ounce of calcium cyanide. After the cyanide was put into the holes, they were filled up with earth. Another plot of two square yards was treated in a similar manner, except that the holes were made two feet apart and were dosed with one ounce of cyanide. An examination of the plots a few days later showed practically no kill of larvae on either plot.

A similar test was made at another place, using one ounce of calcium cyanide, placed at the bottom of a hole four inches deep and three inches in diameter, made by a sod cutter. The cyanide was covered with soil. Other holes the same size and shape as the cyanide hole were made at varying distances from them and an *Anomala* larva in a small wire cage buried in each hole. Eight holes with a larva in each one were made near the hole containing the cyanide. The cyanide and larvae were placed May 28, and examined June 11.

*No. Inches from Cyanide Hole	No. Alive	No. Dead
6	1	1
9	2	0
12	2	0
18	2	0

It may be seen from the tests that the application of calcium cyanide by the hole method was not a satisfactory method of

* Two holes at each distance.

control for *Anomala* larvae. This method has the advantage of not killing the grass. By the broadcast method of application, a good kill of larvae resulted, but the grass was very badly burned. The men broadcasting the cyanide experienced a disagreeable dryness and hoarseness of the throat as well as headaches. More serious effects might be felt if operators were exposed to the action of the cyanide for a longer time. For these reasons it was thought best not to recommend this material for general public use in the control of this insect.

Sodium Cyanide.

This is the ordinary cyanide used in combination with sulphuric acid and water for the fumigation of houses, greenhouses, warehouses, etc., for the control of various insects infesting places that are or can be made air tight. For the control of *Anomala orientalis,* a certain amount of cyanide was dissolved in water and sprinkled on the lawn to be treated, afterward wetting down thoroughly with water from a garden hose.

Three plots were treated with sodium cyanide, using one-eighth, two-eighths, and three-eighths ounces per plot of one square yard. Cyanide was applied as described in the above paragraph. A few days later the plots were dug up and all larvae collected, with the following result:

Ounces per Square Yard	No. Alive	No. Dead
One-eighth	19	4
Two-eighths	6	12
Three-eighths	12	9

Further tests with sodium cyanide were conducted by burying five larvae in a wire cage in the center of a plot one yard square in area. The cyanide was applied as before, dissolved in water and sprinkled on plots with a watering can, then watered wi garden hose.

Ounces per Square Yard	No. Alive	No. Dead	Remarks
One-half	5	0	Grass partly killed
Three-fourths	0	5	Grass all killed
One	0	5	Grass all killed

Another plot of 24 square yards was treated with sodiu cyanide using one ounce per square yard dissolved in water ar applied to the lawn in the usual manner. Treatment was made c June 11, and on June 17, the plot was examined and approx mately 90 per cent. of the larvae had been killed. Most of tl larvae that were left alive were found rather deep in the soil. Tl grass on this plot was all killed.

Other insecticides were tried on a small scale to determi their effect upon *Anomala.* Mercuric chloride was tested on plot of 11 square feet, using one-tenth ounce of this chemica

It was dissolved in water and sprinkled on the soil, but gave only one per cent. kill.

A 10 per cent. kerosene emulsion applied to a plot one yard square was worthless, as no dead larvae were found when the plot was examined a few days after the treatment.

Carbon Disulphide Emulsion.

The most promising of the insecticides and soil fumigants tested was carbon disulphide emulsion. There is a commercial carbon disulphide emulsion on the market which is sold under the name of Kokotone. This was first used on plots one yard square; in the center of each plot a wire cage was buried containing *Anomala* larvae. Each cage was buried between two and three inches deep. The plots were dosed with one-half pint, one-fourth pint and one-eighth pint of Kokotone. The amount of emulsion to be used on each plot was first diluted in about three gallons of water and then sprinkled on the lawn with a watering pot (Plate XXIV, a) then the ground was soaked with more water from a garden hose to wash the emulsion into the ground. On digging up the cages containing the *Anomala* larvae two days later, it was found that in each plot all the larvae had been killed. The grass was slightly injured on the plots receiving one-half and one-fourth pint of emulsion, but the one-eighth pint plot was not noticeably hurt. All the grass which was burned recovered after a short time.

Another lawn of 32 square yards was then treated with Kokotone using one-eighth pint per square yard, applied in the same manner. Four days later, June 30, the lawn was dug into and 61 dead larvae and pupae were found, also two dead adults. In another place a bunch of tall grass under a Spiraea bush was dug up and five dead pupae and two living larvae were found. This amounts to about a 97 per cent. kill. Grass on this plot was slightly injured but soon recovered.

Kokotone was again used late in the fall on a plot of lawn the same size as above. The amount of Kokotone used and the method of application was the same as on the above plot. The temperature of the air was much lower than on June 30, and the soil temperature was 67° F. This probably accounts for the fact that we found only about a 70 per cent. kill when the lawn was examined on October 9. The gas from the carbon disulphide is apparently not given off fast enough at low temperatures to give a high percentage of kill.

It is also apparent from the work done thus far that it is important to saturate the soil with water after the emulsion is applied in order that it may reach and surround the grubs. It works both as a contact insecticide and as a fumigant when applied in this manner.

Home made carbon disulphide emulsion was prepared after a formula given by Leach and Thomson[1] in an article on the "Control of Japanese Beetle Larvae in Golf Greens." This formula calls for 12.5 grams of resin-fish-oil soap dissolved in 87.5 cubic centimeters of water. This is heated until the soap is dissolved, then the solution is allowed to cool, after which 250 cc. of carbon disulphide is added and the mixture agitated until a white creamy emulsion is obtained. We have found that a fairly stable emulsion can be made by substituting either fish-oil-soap or the ordinary naphtha laundry soap for the resin-fish-oil soap, and is satisfactory for immediate use.

Two plots of one square yard each were treated with this emulsion, one made from fish-oil soap and the other from naphtha laundry soap. In the center of each plot before treatment a small wire cage containing two *Anomala* larvae was buried about two or three inches deep. Two liquid ounces of emulsion were used on each plot diluted with three gallons of water and then watered with five gallons of clear water. On examination a few days later, all larvae were found dead. The grass was not injured.

STUDIES OF THE HABITS AND CONTROL OF THE ORIENTAL PEACH MOTH IN 1924.

PHILIP GARMAN.

The Oriental peach moth showed up again in Connecticut in 1924 and was on the whole more abundant than in previous years. It appeared for the first time in appreciable numbers in the peach growing district about Wallingford where a number of growers reported its presence. It was found largely in the southwestern section of the State and in the central section extending northward from New Haven into Hartford County. One orchardist near the Massachusetts line stated that he had seen "worms" in his peaches similar to those of the Oriental peach moth, but this locality is well to the north of the main infestation and its presence should be observed another year in the same locality in order to make sure that it has become established. A questionnaire sent out in October to about 20 peach growers indicated that the insect was present in 11 of their orchards, but most of those reporting it were of the opinion that it did little damage. In the orchard at Conyers Farm, Greenwich, about the same amount of damage as occurred last year was observed by the men in charge, but the possibilities of the pest are evident in the amount of damage found in some of the experimental blocks, where the infestation amounted to from 14 to 23 per cent. of the crop. In that orchard the variety most heavily infested was Belle of Georgia.

[1] Journal of Economic Entomology, Vol. 16, page 312.

Observations on the life history of the insect were made during the summer and though necessarily incomplete, some of the results are given herewith.

June 9—No sign of the Oriental peach moth at Greenwich or New Haven.
June 23—A few tips infested at Greenwich, the larvae one-half or two-thirds grown.
June 25—First infested tip seen at New Haven.
June 30—Most of larvae have left twigs at Greenwich; signs of one having entered a peach—doubtful.
July 3—Pupae obtained from June 23 material.
July 9—Four adults emerged from June 23 material.
July 10—Three adults emerged from June 23 material.
July 14—Many young larvae observed in tips at Greenwich—one in peach.
July 21—One adult emerged from July 23 material.
July 25—One egg found on tree at New Haven.
July 28—Many larvae observed in young orchard at Greenwich.
Aug. 3—Eight adults emerged from July 14 material.
Aug. 5—One adult emerged from July 14 material.
Aug. 7—Three adults emerged from July 14 material.
Aug. 8—One adult emerged from July 14 material.
Aug. 11—Four adults emerged from July 14 material.
Aug. 12—Two adults emerged from July 14 material.
Aug. 13—Twelve adults emerged from July 28 material.
Aug. 14—Four adults emerged from larvae obtained July 28.
Aug. 14—One adult emerged from larvae obtained July 14.
Aug. 15—Collected many small larvae in tips of young trees.
Aug. 15—Hale thinnings gave a total of 1 per cent. infested.
Aug. 25—Two adults emerged from July 28 material.
Aug. 28—Two adults emerged from July 28 material.
Sept. 1—One adult emerged on this date.
Sept. 9—One adult emerged on this date.

Grouping the adult emergence (from larvae collected June 23, July 14 and 28; August 15 and 22 and September 13, 25, 29 and October 1), we obtain the following results:

July 1–9	0 Adults
July 9–21	8
July 21–Aug. 1	0
Aug. 1–7	12
Aug. 7–14	24
Aug. 14–21	15
Aug. 21–Sept. 1	14
Sept. 1–9	2
Sept. 9–31	0

All larvae spinning after August 25 hibernated and did not pupate. Larvae were abundant in fruit from September 13 till October 2, but none of the larvae obtained at this time pupated.

We estimate the presence of at least three broods in Connecticut, but it is evident that adults of the insect did not reach the maximum period of abundance in 1924 until August and that the larvae were most abundant from August 15 until the last of September. From this it is apparent that some of the control

measures must be used towards the latter part of the season if the insect is to be controlled effectively.

A general summary of the habits of the Oriental peach moth has already been given[1] and it is advisable to mention here only such features as bear directly on its control, or affect its economic status. The eggs are laid on the underside of the peach foliage and sprays must be made to cover the leaves thoroughly if control is to be secured. The very short length of the egg stage naturally necessitates frequent nicotine or other egg sprays and at least one a week would appear to be necessary from this standpoint alone.

The young larvae soon after hatching may be killed with arsenicals[2] but the older larvae are not easily killed as has been repeatedly demonstrated. Thus we find arsenical applications of little use in mid-summer when the larvae are migrating from twigs to fruit, but later in the season when many go directly into the fruit, such applications may possibly be more effective.

The larvae frequently spin on the ground or near the ground on the trunk and clean cultivation together with such controls as the use of paradichlorobenzene, winter strength lime-sulphur and the like should be of help. The silken cocoon of the larva is water proof and it is not known exactly how sprays of the sort mentioned affect the larvae. Owing to the fact that many of the drop fruits which fall shortly before harvest time contain larvae, it would seem advisable to remove this fruit from the orchard and destroy it as soon as possible because it furnishes material for reinfestation.

Larvae entering peaches some time before ripening usually leave conspicuous evidence of the infestation due to the fact that gum is rapidly thrown out by the growing peach. Early fruit, too, is often infested by larvae migrating from the twigs. As a result there is usually little difficulty in grading out early infested peaches. Larvae which enter the fruit, however, when the latter begins to ripen (owing to the fact that little gum is thrown out and to the fact that many very minute larvae enter direct from the egg) cause much infested fruit which cannot be detected. Many of the larvae enter at the stem end and as shown in the illustrations (See Plate XXVII, a), leave only a very insignificant trace at the point of entrance. Still others enter through the side of the fruit and the frass thrown out at the point of entrance may be washed off or rubbed off in handling which results in a fruit wholly without external signs of infestation. Such fruit cannot be graded out and some of it naturally finds its way to the consumer as well as being shipped into districts where the Oriental peach moth is not yet established; sometimes with unfortunate results.

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[1] Britton, W. E., Conn. Agr. Exp. Sta., Bull. 256: 284–287; 1923.
[2] Peterson, Alvah, Journal of Economic Entomology, 13: 391–398; 1920.

We have been much surprised at the amount of fruit infested in some orchards in 1924, especially when the amount of twig injury was relatively small as will be seen in Table 4. Such an increase may be due to the normal increase of the pest but there are also other possibilities—namely that of the shipment of wormy fruit from other infested sections and the consequent increase of the insect in the particular district concerned. Possibly there is also a natural flight of the moths in late summer similar to the case of the cotton moth and apparently so with the corn ear worm.

The adults are active about sundown, but have been seen near midday by some workers[1]. There is some possibility that adults may be killed by nicotine or other dusts; but not much is known of this phase of the problem.

In general the history of the Oriental peach moth thus far has been that it appears in destructive numbers for a few years, and then becomes relatively scarce. This has apparently been the case in Maryland and Virginia, due without doubt to the beneficial action of parasites. How often these waves of injuriousness will occur remains to be seen, and what will happen next year in Connecticut is only a guess but it will probably increase in intensity in sections hitherto not greatly affected, and decrease in sections where the greatest amount of damage was done in 1924.

Control Experiments.

The only field control experiments were conducted at Conyers Farm and were made possible through the kindness of Messrs. G. A. Drew and H. B. Reed, who granted the use of the treated blocks and furnished the labor for spraying and other operations. Four plots were used each consisting of six rows containing 54 to 61 trees. Nearly all were bearing, well cared for, and fertilized so that good growth resulted and a good crop of fruit was harvested, amounting in many cases to 10 to 15 baskets per tree.

The ingredients of the sprays and dusts used are as follows:

(1) Nicotine sulphate, ½ pint to 50 gallons.
(2) Lead arsenate, 1 pound to 50 gallons.
(3) Self-boiled lime-sulphur, 8-8-50 formula.
(4) P. & G. Naphtha soap, 2 pounds to 50 gallons.
(5) Casein lime spreader, ½ pound to 50 gallons in sprays containing lead arsenate and self-boiled lime-sulphur.
(6) 90–10 sulphur-arsenate dust.
(7) Commercial nicotine dust, guaranteed 2.7 per cent. nicotine.

The following applications were made on the four different blocks:

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[1] Guyton, T. L., Journal of Economic Entomology, 17: 415; 1924.

(1) Fungicide only—self-boiled lime-sulphur, June 9 and July 14.
(2) Self-boiled lime-sulphur plus lead arsenate, plus nicotine sulphate, plus casein lime, June 9 and July 14; nicotine sulphate plus soap, June 30, July 28 and August 15.
(3) Self-boiled lime-sulphur plus lead arsenate, June 9 and July 14.
(4) Sulphur arsenate dust followed by nicotine dust, June 9 and July 14; nicotine dust, June 30, July 15 and August 2.

Counts were made of all drop fruits from 10 selected trees in the center of each block and of all fruit from five selected trees in each block, the scoring being done by exterior examination, grading into infested and uninfested lots. A number of each of these lots were then cut open and the correction for infested peaches overlooked in the first grading, applied to those figures. The results are seen in Table 3.

No conclusions will be drawn from these experiments until checked by similar tests, but they are presented here in order to show what was obtained in the way of control measures in 1924.

ORIENTAL PEACH MOTH CONTROL—1924.

TABLE 1—PICKED FRUIT FROM FIVE SELECTED TREES.

Block No.	Treatment	Good	Infested	Per Cent. Infested
1	Fungicide only, 2 sprays	3,237	393	10.8
2	5 sprays containing nicotine sulphate 2 with lead arsenate	2,528	190	6.9
3	Fungicide plus lead arsenate	3,539	408	10.3
4	5 dusts containing nicotine, 2 with arsenate	1,847	63	3.2

TABLE 2—ALL FRUIT FROM FIVE SELECTED TREES.

1	....	4,040	655	13.9
2	....	3,518	301	7.8
3	....	4,036	556	12.1
4	....	3,867	250	6.0

TABLE 3—CORRECTED FIGURES FROM TABLE 1 BASED ON CUT FRUIT.

1	....	2,786	844	23.
2	....	2,167	351	14.
4	....	1,692	218	11.

TABLE 4—TWIG COUNTS OF ALL TREES MADE JULY 28, 1924.

Block No.	Treatment	No. Trees in Block	Total No. Injured Twigs	No. Injured Twigs per Tree
1	....	54	318	5.8
2	....	61	177	2.9
3	....	56	192	3.4
4	....	56	178	3.1

EFFECT OF VARIOUS INSECTICIDES ON THE EGGS OF THE EUROPEAN RED MITE (P. pilosus C. & F.)

PHILIP GARMAN.

Since the publication of Bulletin 252, on the European red mite, a number of tests have been made of the killing power of certain insecticides on the winter eggs. These tests are laboratory tests and results are comparable to what was obtained in previous experiments. For convenience, two proprietary oils now on the market have been compared and the results are shown in Table 2. Results in this table are a total of all tests made to date, including those reported in Bulletin 252.

TABLE 1.

Materials Used	Total No. of Eggs	Hatched Number	Hatched Per Cent.
1. Niagara dormant dust	119	19	15.9
2. Soluble sulphur 1 oz. in 1 quart	115	29	25.2
3. " " " " "	198	32	16.1
4. " " " " "	478	98	20.5
5. " " " " "	230	99	43.0
6. " " " " "	201	49	24.3
7. Sunoco spray oil 1–15	231	1	.4
8. " " " 1–15	323	12	3.7
9. " " " 1–15	548	3	.5
10. " " " 1–20	227	1	.4
11. Carboleine 1–15	282	3	1.0
12. " 1–20	332	2	.6
13. Volcks 3%	467	2	.4
14. " 6%	469	9	1.9
15. Sherwin Williams Free Mulsion 1–15	202	4	1.9
16. Check—no treatment	483	225	46.5

Note. Tests 2-5 were made with fresh soluble sulphur of good yellow color; No. 6 with the same material after standing a year.

TABLE 2.

Materials Used	Total No. of Eggs	Hatched Number	Hatched Per Cent.
1. Scalecide 1–15	4,853	238	4.9
2. " 1–20	182	0	0.0
3. " 1–25	1,258	68	5.4
4. " 1–50	968	66	6.8
5. Sunoco 1–15	1,055	18	1.7
6. " 1–20	227	1	.4
7. " 1–25	180	6	3.3
8. " 1–50	325	56	17.2

The percentage of hatch in the two lots should not necessarily be taken to indicate superiority of either oil, since the experimental error and variation is considerable. The experiments, however, indicate consistently that a dilution of 1 to 20 or 1 to 25 does not greatly reduce the toxicity of miscible oils of this type. As indicated in Table 1, soluble sulphur compounds do not give

as high a mortality in laboratory tests, although they have in common with oils, the property of covering all parts of the twig and "crawling" into spots not actually reached by the spray.

Some criticism of Table 14, Bulletin 252, has been received from manufacturers. Owing to omission of results in Table 11 from the final summary, Sunoco Spraying Oil was placed at the bottom of the list. Revised from the data as summarized in Table 14 from previous records in Bulletin 252, the last five items should read.

Exp. No.	Treatment	Hatched Per Cent.	Possible Kill Per Cent.	Number Eggs Used
10	Wormol	9.2	83.4	711
11	Scalecide	6.8	87.3	8,154
12	Sunoco Spray Oil	4.3	92.1	1,573
13	2% Red Engine Oil Emulsion	3.3	93.8	968
14	Jarvis Compound	.6	99.0	896

The original idea of this table was not to indicate superiority of any particular product especially where percentages are close, since the conditions of experiment varied, but was intended to show the increased kill in the case of certain types of miscible oils over other ovicides, namely lime-sulphur compounds or substitutes. However, in view of the possible harm done to certain manufacturers of spray materials we take pleasure in revising the latter part of this table and presenting it in corrected form. The figures represent a summary of all tests made with different dilutions and obviously should not be used as a direct comparison of different products.

THE ALCOHOL-FORMALIN SOLUTION FOR CONTROL OF AMERICAN FOUL BROOD.

PHILIP GARMAN.

Dr. J. C. Hutzelman was the first to demonstrate that combs containing American foul brood may be successfully sterilized with a mixture of formalin and alcohol. For this purpose he used[1] a solution of 20 per cent. formalin in alcohol, soaking the combs 48 hours after extracting all honey. He reports the successful sterilization of many combs. These facts together with the recommendation of this treatment by one of the largest manufacturers of bee supplies makes it advisable to explain the methods more fully, examining the constituents of the solution in detail in order to know what may be expected of it.

The procedure in general[4] is as follows.—Infected hives are removed to a "hospital yard" away from the main apiary, the bees shaken, hives disinfected and the combs treated according to the following method. The cells are uncapped, honey extracted and the combs are then placed in warm water which is later thrown

[1] See references at the end of this article.

out in the extractor. This treatment is necessary in order to remove all traces of honey which might remain in the combs and interfere with the disinfection. The combs are then placed in the alcohol-formalin solution and allowed to remain 48 hours after which the formalin solution is extracted and the combs allowed to dry. After these operations are complete, the bees are given a new queen and returned to the disinfected hive and combs.

Some workers state that it is not necessary to uncap all cells before immersion in the solution, but the advisability or inadvisability of this method has not been fully demonstrated. Knowing, however, the nature of the disease, that is, its bacterial origin, and the difficulty in getting rid of such diseases, it seems necessary to omit no precautions and to exercise the greatest care in treating the combs, It is known, moreover, that spores of American foul brood may remain without germination for many years and the inadvisability of basing conclusions on one season's work seems undesirable, unless of course the disease reappears within that time.

The minimum amount of the solution required is not less than five gallons and for practical purposes not less than 10 gallons should be purchased. For larger amounts special tanks should be constructed and special equipment obtained[4]. The material may be used repeatedly according to the manufacturer's recommendations.

Alcohol-formalin solution is very irritating and troublesome to handle. The fumes given off are stifling especially if confined to a closed room. We therefore recommend that it be handled in the open or in a place where there is plenty of ventilation. If the contents of each comb after soaking in the solution, are shaken back into the treating tank, fumes will be produced which will cause much discomfort to the operator. It is best to place the combs in the extractor direct, cover same and extract under cover; and it is especially desirable to handle the combs being treated with rubber gloves or some tool which will prevent the solution from coming into contact with the hands.

Formaldehyde gas dissolved in water is known commercially as formalin, and contains about 40 per cent. formaldehyde gas. Information about the process of manufacture reveals that formaldehyde is made from methyl or wood alcohol and the solution usually contains some of this chemical as a stabilizer. In nearly all formalin solutions obtained on the market there is also some paraformaldehyde, a white insoluble substance derived from formaldehyde. If this substance remains in the combs they will smell of formaldehyde long after the combs have been dried. The best way to remove paraformaldehyde should enough remain to be noticeable, is apparently by the use of sodium sulphite*

*A chemical used in photography costing about 25 cents a pound.

solution. Combs containing a large amount of paraformaldehyde were successfully treated at the Experiment Station by soaking after drying in a solution of this material containing 1 pound in 8 gallons of water.

The question very naturally arises whether it will pay the average small beekeeper to disinfect with alcohol-formalin solution. The minimum amount of the solution which may be used is about 10 gallons. At present prices this will cost about $15.00. It will follow that should the value of the stock or combs infected rise greatly above this initial cost, it would be to the advantage of the person interested to make use of the solution: otherwise it would seem better economy to destroy completely the infected bees and equipment. For the larger beekeeper who is liable to encounter the disease year after year, it should be of more value. Reports from other states seem to be favorable, but the opinion of Connecticut beekeepers is not definitely formed regarding the economic value of the treatment and several years will probably elapse before we shall know whether it will receive the endorsement or condemnation of beekeepers in general.

So far our experiments have not demonstrated conclusively whether the solution will or will not control American foul brood. Work along this line is to be continued.

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THE EGG OF THE BLUEBERRY SPITTLE-BUG,

Clastoptera proteus Fitch.

Philip Garman.

Eggs of this species were obtained in 1924 from bugs kept in confinement on growing plants. A search during the winter brought to light many old egg punctures and some live eggs in a similar position on wild bushes. Since the eggs of the species have not been recorded it seems advisable to describe their general form and location.

The eggs of *Clastoptera proteus* are similar to that of the alder bug *C. obtusa* and are laid beneath the bark on the outer twigs. They are sometimes thrust directly into the plant parallel to the axis of the stem and sometimes diagonally. Not more than three have been observed in a single puncture though only one may sometimes be found in each. Some of the characteristic punctures are shown on Plate XXX, f.

Total length .7 mm. greatest width .35 mm.; rounded at one end and tapering to a rather definite point at the other.

The eggs of six species representing four of the five genera of spittle-bugs occurring in this section are now known; leaving only the egg laying habits of *Aphrophora* species yet to be discovered. In general it may be stated that those eggs known so far are similar in form, being pointed at one end and rounded at the other, the only great differences being those of size. All are placed on the plants themselves, being either thrust into dead stems, into the sheath of the growing plant or just beneath the bark on new growth. The function of the rather stout ovipositors of members of the group therefore is plainly evident.

A list of references relating to the eggs and egg laying habits is given herewith.

Philaenus lineatus (Linnaeus), Barber, G. W. and Ellis W. O., Psyche, 29: 3: 1922. Garman P., Conn. Agr. Exp. Station, Bull. 230; p. 328: 1921.

Philaenus leucophthalmus (Linnaeus), Barber, G. W. and Ellis W. O., Psyche, 29: 3: 1922.

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Philaronia bilineata (Say). Barber, G. W. and Ellis W. O., Psyche, 29: 3: 1922.

THE WOOLLY APHID OF APPLE AND ELM.

Eriosoma lanigerum Hausman.

The apple tree woolly aphid is said to occur throughout the world wherever the apple is grown. In England it is called the "American blight" and in Germany the "Blutlaus." It is a bark feeding aphid with two forms; one on the roots and the other on the twigs and branches. It is generally noticeable above ground, on account of the bluish-white patches on the twigs, shown on Plate XXIX, c with reddish-brown aphids close to the bark. The whitish color is due to many minute filaments of wax secreted and protruded by small pores in the epidermal coverings of the bodies of the aphids. These aphids often cluster in wounds such as scars, cankers or where branches have been cut off, and prevent their healing. In some cases, galls are formed on the twigs by the clusters of woolly aphids, and these galls together with the

whitish wax adhering around the margins of wounds are an indication of the presence of the pest. Several years ago, a seedling apple came up in a protected place just south of one of the Station buildings, where it was allowed to grow for several years. Each summer nearly every branch bore one or more of the bluish white patches, each patch being a colony of woolly aphids. Later the little tree was literally covered with swellings or galls on the twigs and branches as the result of the infestation, and the tree was finally removed to make room for needed improvements.

On the roots, galls are nearly always formed by this insect, and where this infestation is heavy, the root system may be only a mass of galls. These galls decay, often ruining the root system of the tree. I well remember some 12 years ago, a man in Groton purchased several hundred apple trees from a Tennessee nursery, and when they arrived, many of the trees had lost all of the smaller roots by decay following woolly aphid infestation. Some of the old stump roots were photographed and are shown on Plate XXIX, b. Most of the trees had galls on the roots but many of them had decayed and were worthless for planting. I was asked to make a statement and issue a certificate regarding the condition of this stock, to be used by the purchaser in making adjustment with the nurseryman. I also wrote to the nurseryman and to the official in charge of nursery inspection in Tennessee, and hope that such stock will not again be shipped into Connecticut. The root form also produces the white wax filaments but these are shorter and less conspicuous than is the case with the aerial form.

The woolly aphid is a much more serious pest further south than in Connecticut, but no doubt it causes some damage here. Nursery trees and young orchard trees are more seriously injured than larger and older orchard trees. The Northern Spy and some other varieties are said to be more or less exempt from attack. In examining apple twigs in the spring of 1924, evidences of the presence of woolly aphid were found in every one of 18 orchards submitting twigs, covering all parts of the State except New London and Windham Counties. Though perhaps the woolly aphid is not a major pest in Connecticut, some attention should be paid to it particularly in nurseries, and in newly established orchards. We believe that it will not seriously injure trees in Connecticut after they have become well established and have reached bearing size.

Gillette and Taylor state that "If Colorado orchardists should vote their opinion as to what ought to be called the worst orchard pest in the State, it is very doubtful whether the codling moth or the woolly aphis would carry off the honors."[1]

Life History.

The winter eggs are laid in the crevices of the bark on elm trees probably in September, and hatch in early spring. The aphids hatching from these eggs are wingless females, called stem mothers, which feed upon the expanding leaves and become mature late in May and cause the leaves to curl or form rosettes. Their young are also wingless and are born alive like the other summer generations of most aphids. The next generation, however, have wings and are known as spring migrants; they mature the latter part of June and migrate to apple trees. Sometimes they go to pear, quince, hawthorn or mountain ash. There are three summer generations in Maine[3] and in August winged females appear and shortly afterward lay the winter eggs.

According to Slingerland and Crosby, the development of the root form is quite similar to that of the form on the twigs and branches, though perhaps not fully worked out; also that "many of these wingless agamic nymphs persist on the roots, and some of them even on the tree above ground, all the year through even in New York State and other cold northern latitudes."[4]

Control Measures.

In general, orchardists should be advised not to plant trees with many galls on the roots. Nursery trees which have been seriously injured by the woolly aphid should be destroyed. Those which are not injured but which show evidences of infestation should before planting be either fumigated with hydrocyanic acid gas, or treated by dipping the roots in a nicotine solution containing a spreader, or in kerosene emulsion containing 15 per cent. kerosene. Hot water (130°-150° F.) is also recommended. Lime-sulphur, however, should not be used, as it may cause injury to the small roots.

In Missouri in 1896, experiments were rather successful in treating ten year old trees in the orchard by removing four inches of the top soil around each tree for a distance of two feet from the trunk and scattering evenly over this area four or six pounds of tobacco dust, then replacing the soil. With nursery trees, the dust was placed in trenches close beside the rows. In Georgia[5] more than ten years later, similar and more detailed experiments with various forms of tobacco in excavated areas and trenches gave very unsatisfactory results, but by removing three inches of the surface soil extending from one and one-half to four feet from the trunks, depending upon the size, and treating with 15 per cent. kerosene emulsion, good results were obtained. From three gallons of this emulsion on the smaller areas, to six gallons on the larger, saturated the soil to a depth of from two to four inches, and it gradually permeated the soil to a depth of a foot or more and the odor lasted for many weeks.

During the seasons of 1914 and 1915, Mr. B. R. Leach of the

Bureau of Entomology, conducted experiments against the woolly aphis in Virginia using various materials including kerosene emulsion, sodium cyanide, and carbon disulphide emulsion. His best results were obtained with carbon disulphide emulsion at the rate of one-half pound in four gallons of water, thoroughly agitated. A shallow basin was made around the tree and three-fourths of a gallon of the emulsion per square foot of soil was applied in the basin. He found this method quite satisfactory on small trees, where the conditions are favorable. The applications can be made at any time during the summer months, but are successful only when the soil is moist. Since Mr. Leach carried on these experiments, a soap emulsion of carbon disulphide has been manufactured and is now sold on the market. It is also possible to make at home a fairly good emulsion, and it is believed that these soap emulsions would also be effective in killing the root forms of woolly aphis, particularly after the proper proportions have been determined. Such emulsions have been used in this Department to kill the grubs of the Asiatic beetle, and did not injure the grass.

The aerial form of the woolly aphid can readily be killed by spraying with kerosene emulsion, or with nicotine sulphate and soap.

Literature.

The economic literature of this species is very voluminous, and only a few references are given here.

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[5] Smith, R. I., Bulletin 23, Georgia State Board of Entomology, 1907.

[6] Stedman, J. M., Bulletin 35, Missouri Agricultural Experiment Station, 1896.

THE LIME TREE WINTER MOTH.

Erannis tiliaria Harris.

This native American insect occurs throughout the eastern United States and Canada, westward to the Rocky Mountains. The larvae feed upon the foliage of apple, pear, linden, birch, elm, oak and hickory and probably other forest trees. As a rule it is not very abundant in Connecticut and therefore little attention has been paid to it. Occasionally it becomes so abundant as to cause damage by defoliating trees, and such may be the case in Connecticut in 1925, as the male moths were very abundant in October and November, flying around electric lights in cities and villages. Not only were the moths noticeable in Connecticut, but were reported as being abundant throughout Massa-

chusetts and portions of New York State. On November 1, a specimen of the male was received from Sharon with a statement that it was very abundant there, and since then I have learned that the caterpillars of this insect in the summer of 1924 caused noticeable damage to the beautiful elm trees on the village green. Hence, all persons responsible for the care of valued shade trees, whether on public or private grounds, should be warned to look out for the depredations of this insect early in the coming summer.

Other common names of the caterpillars are: lime tree span worm, lime inch worm and ten-lined inch worm.

Injury.

The injury consists in the caterpillars feeding upon the leaves during the month of May. This may well be ascribed to canker worms as it has a similar appearance and occurs at about the same time. In fact the larvae or caterpillars are often found feeding with canker worms, but as they are larger and have a more distinctly yellowish color on the lower portion of the sides and on the under surface, they can readily be distinguished from them. In 1912, this insect appeared in large numbers in western New York, and riddled the foliage of apple and cherry trees along the roadsides and to some extent in commercial orchards. Linden and elm trees were also partially defoliated.[3] In 1914, an outbreak of this insect was reported from Ulster County, N. Y., and orchard and woodland trees were attacked.[2]

At first the caterpillars eat elongated holes, but when they are abundant they completely riddle the leaves.

Habits and Life History.

Like the canker worms, this insect has one generation annually, the females are wingless, the caterpillars feed upon the leaves at the same time of the year and loop in crawling. The eggs hatch in April or early in May and the caterpillars become fully-grown early in June and transform to the pupa stage in cells in the ground. Some may pupate in May and usually all have pupated by the middle of June. The caterpillars have the habit of remaining rigid in one position or feigning death, sometimes fastened only at one end and the other standing out in a straight line like a twig. In Connecticut the adults for the most part emerge in the fall, though according to Dr. Saunders, in Canada fall emergence is rare and most of them emerge in spring.

One of the best biological accounts of this insect published in recent years is by Professor W. J. Schoene, in Bulletin 421, of the New York (Geneva) Agricultural Experiment Station, page 376, Plates V and VI, May, 1916, and the present writer has drawn upon it freely. Professor Schoene records no observations on the hatching of the eggs, but states that the females in a cool

room continued to oviposit for a week, scattering their eggs over the bark, some in cracks, some under the edges and some on exposed situations; also that 533 eggs were taken from the abdomen of one female.

On October 15, 1924, the males were quite abundant around electric lights, and several were collected. They did not disappear at once but were seen on warm nights through the remainder of October and November. Mr. Rogers spent some time looking over trees but did not find any females. The writer collected three females from the trunks of woodland trees, November 20, in Macedonia State Park, Kent.

The Station collection contains males collected by the writer in New Haven, 25 November, 1905; 7 November, 1906; 15 October, 1924. Two specimens from Pemaquid Point, Me., collected in August, 1906, by Professor H. W. Foote are also in our collection.

Descriptions.

Egg: Cream color, shape somewhat cylindrical, bluntly rounded at the ends. The sides and one end where the cap is situated are marked with compressed hexagonal reticulations, most pronounced on the cap. Laid singly or sometimes in loose clusters generally attached by one side. Length about .9 mm., width about .52 mm. The eggs are shown on Plate XXX, c.

Larva: A bright yellow looping caterpillar with rust-brown head and ten crinkled black lines extending longitudinally along the back. There is great variation in width of these lines, so that the dorsal view of some caterpillars is nearly black, and others are distinctly light-colored. The outer black line or stripe is often heavier or more pronounced than the others and is wavy, giving a scalloped appearance to the margin. The under surface is yellow and paler than the yellow between the black lines. Legs and prolegs yellow. Length of mature larva, nearly 1.5 inches. See Plate XXX, d.

Pupa: The pupae are brown, slightly more than half an inch in length and rather stout, though the females are somewhat shorter and thicker than the males. The pupae of both sexes terminate in a sharp point.

Adults: Male, forewings buff, marked transversely with two wavy brown bands, and sprinkled with fine brownish dots; rear wings, lighter buff or nearly white with no prominent markings. Scales of head, thorax, abdomen, and legs and antennae about the same tint as ground color of forewings. Wing-expanse about 1.75 inches.

Female, wingless, greenish-yellow, varying to light gray or brown, with two rows of black spots on the back. Legs and antennae are ringed with black and yellow or the ground color. Length about half an inch.

Both sexes are shown on Plate XXX, a and b.

Methods of Control.

The best means of control is to spray the foliage in May with lead arsenate as is done for canker worms. The poison may be applied as soon as there is sufficient foliage to hold the poison. If applied too early, other leaves will put out upon which the caterpillar may feed and two sprayings may be required. If applied too late, considerably injury will result before the caterpillars are killed. In the average season, about the middle of May will probably be the best time. From three to five pounds of powdered lead arsenate per 100 gallons of water may be used, and if one pound of caseinate spreader is added, it will be possible to give a better coating to the foliage.

Literature.

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[2] Felt, E. P., 30th Report, New York State Entomologist, page 59, 1914.
[3] Schoene, W. J., New York (Geneva) Agr. Expt. Station, Bull. 423, page 376, 1916.
[4] Slingerland, M. V., and Crosby, C. R., Manual of Fruit Insects, page 89, 1914.

SUBSTANCES ATTRACTIVE TO THE CABBAGE MAGGOT FLY.

R. B. Friend.

The experiment described below was carried on at the Experiment Station Farm, Mount Carmel, in the spring of 1924 for the purpose of finding some substance which would attract adult females of the cabbage maggot (*Hylemyia brassicae* Bouché) before oviposition occurred. This fly lays its eggs just below the surface of the ground close to the stem of the young cabbage plant. Believing that the odor of the cabbage plant would be attractive to the flies, especially if combined with some sweet substance, materials were tried which contained extracts of the cabbage plant or pieces of the plant itself. In view of results obtained by the New Jersey Station with a honey and yeast mixture in attracting the adults of *H. ceparum,* this medium was used extensively in our experiments. The following mixtures were tried over periods of varying length, the number of trials depending on the promise shown by the bait.

1. Residue from distilled extract, honey, yeast and water.
2. Pieces of cabbage, honey, yeast and water.
3. Pieces of cabbage, molasses, yeast and water.
4. Brown sugar, yeast and water.
5. Extract of the cabbage plant.
6. Residue from distilled extract.
7. Extract of the cabbage plant and ground charcoal.
8. Honey, yeast and water.
9. Molasses, yeast and water.
10. Pieces of cabbage, brown sugar, yeast and water.

The extract of the cabbage plant was prepared by grinding the entire plant in a food grinder, adding to this an amount of 95 per cent. ethyl alcohol in cubic centimeters equal to the weight of the cabbage in grams (this amount was sufficient to cover the ground cabbage) and letting this mixture stand at room temperature a week. It was then filtered in a press, and the resulting clear alcoholic extract distilled under reduced pressure at bath temperature of 65°-75° C. to about one-twentieth of the original volume. Most of the odoriferous substance apparently remained in the residue. Any reference to extract refers to the filtered but not distilled alcoholic extract, and references to residue refer to the residue left after distilling the extract.

The material in each trial was placed in the pan of a Hodge fly trap and kept from drying by the addition of water. About five grams of honey, molasses or sugar was used with enough water for 60 cc. About 20 cc. of residue was used, and when yeast was used, a cube five millimeters thick was found sufficient. The extract was always used pure. If pieces of cabbage were used, five or six pieces of leaf about 2 cm. square were added. In the trials with charcoal, two teaspoons of ground charcoal were added. The traps were set on the ground and in the rows between plants, being about twenty feet apart. The cabbage plot contained three rows of plants and was about 200 feet long. Examination of traps was made each day, the flies killed and removed, and water was added if necessary. One of these traps is shown on Plate XXXI, a.

The experiment was carried on from May 20 to June 10, and Table I gives the results obtained. These figures are totals of five species of the genus *Hylemyia, H. brassicae* Bouché, *H. ceparum* Meigen, *H. cilicrura* Rondani, *H. cinerella* Fallen, and *H. trichodactyla* Rondani, of which *cinerella* and *ceparum* probably do not attack the Cruciferae. It will be noticed that between May 22 and May 27, when conditions were similar for all materials then tried, that the residue-honey-yeast-water formula proved by far the most attractive, and the cabbage-yeast-molasses-water formula was next, although the difference between the latter and the molasses-yeast-water formula was insignificant. If the table is examined carefully and the dates noted, it will be apparent that the residue-honey-yeast-water formula is far superior to any other tried. The addition of yeast in quantities sufficient to form a noticeable ferment was of distinct value, as without this the materials were much less attractive. Other baits tried but found of little value were mustard oil (allyl isothiocyanate), allyl alcohol, ethyl alcohol, methyl alcohol, isopropyl alcohol, butyl alcohol, honey, brown sugar, water, and yeast. These were used with water in all cases. The addition of charcoal removed the attractiveness. The residue in itself was by no means as attractive as when mixed with yeast and honey.

The durability of the attractiveness of the materials was observed, and Table II gives these figures. The residue-honey-yeast-water formula was by far the most durable and the pure extract the least. The volatility of the alcohol in the extract rendered it unattractive after a day. This was also true of the alcohols tried. In one instance the residue-honey-yeast formula remained attractive two weeks with the addition of water only. In Table II, the dates begin at May 16, as four traps were set on that date, although the main part of the experiment did not begin until May 20. As soon as any yeast bait became dry, the yeast died and had to be replaced. The need of sugar as food for yeast is obvious, and the sugars are, of course, attractive in themselves.

The total number of flies of all species caught was 1,841 females and 583 males, and the greatest number in any one day was 70 with the pure extract on May 23, and 61 with the residue-honey-yeast-water formula on May 27. An estimation based on a determination of 348 individuals taken at various times in the course of the experiment indicates that 68 per cent. of the females and 76 per cent. of the males were *H. cilicrura* and only five per cent. of the females and two per cent. of the males were *H. brassicae,* these two species being the ones with which we were most concerned. The relative extent to which these species attack cabbage is not known. A warm bright day gave more flies than a day that was cool or cloudy. The occurrence of rain gave little trouble with the baits, as the wire of the traps protected the pans and prevented an overflow. The traps were staked down to prevent the wind from turning them over. A change in the relative position of the traps indicated that this factor was negligible. The plot sloped bnt little and conditions were uniform in this respect. The great predominance of females over males might have been due in part to the odor of the cabbage plant, the females heing attracted to this plant to oviposit. Several females were examined for eggs, and of those examined 75 per cent. contained eggs in varying stages of development, the number of eggs per female running up to 44. In a series of similar experiments with the onion maggot (*Hylemyia ceparum*) all the females were examined each day, and eggs were found in from 76 to 91 per cent. of the individuals. There is no doubt but what most of the flies caught were females, and of the females, the great majority had not finished ovipositing.

No check plot was used, so no definite idea of the effectiveness of the use of traps as a control measure could be obtained. On May 8, 570 plants were set out and on June 13, 569 were still growing. When a plant wilted, it was at once examined for maggots; in only one case were maggots the cause of the death of a plant. Several plants were retarded by other factors, including cutworms, and there is a possibility that some maggots

were present in numbers too small to kill or wilt the plant. On August 7, 163 plants were so retarded as to be useless. The cabbage maggot was not a serious pest around New Haven this season.

In experiments elsewhere, allyl isothiocyanate and allyl alcohol have proved attractive to *Hylemyia cilicrura* and *Hylemyia ceparum*, and further trials will be made with these materials with the cabbage maggot.

I am indebted to Dr. H. C. Huckett for assistance in determining the species of Anthomyiinae taken in the experiment.

TABLE I.

NUMBER OF FLIES CAUGHT AT MOUNT CARMEL, 1924.

Formulae	Total Female Male	Average per trap Female Male	Average per trap May 22-27, inc. Female Male	Average per trap May 20-June 3 inc. Female Male
Honey-Yeast-Water-Cabbage........	21 traps	21 traps	5 traps	18 traps
May 20-June 5, inc .	297 85	14.1 4	10.2 3.8	14.6 4.4
Honey-Yeast-Water-Residue.........	33 traps	33 traps	5 traps	18 traps
May 20-June 10, inc.	466 118	14.1 3.6	32 8.6	17.5 4.7
Residue...........	27 traps	27 traps	8 traps	21 traps
May 20-June 10, inc.	282 87	10.4 3.2	11 4.5	11.3 3.6
Extract...........	28 traps	28 traps	15 traps	28 traps
May 20-June 3, inc.	337 129	12 4.6	14.7 5.7	12 4.6
Extract-Charcoal...	7 traps	7 traps		
May 20-27, inc.....	52 11	7.4 1.6		
Yeast-Honey-Water.	2 traps	2 traps		
May 22-23, inc.....	17 6	8.5 3		
Yeast-Brown Sugar-Water..........	5 traps	5 traps	5 traps	
May 22-27, inc.....	73 23	14.6 4.6	14.6 4.6	
Yeast-Molasses-Water..........	5 traps	5 traps	5 traps	
May 22-27, inc.	84 27	16.8 5.4	16.8 5.4	
Brown Sugar-Yeast-Water-Cabbage..	5 traps	5 traps	5 traps	
May 22-27, inc.....	44 18	8.8 3.6	8.8 3.6	
Molasses-Yeast-Water-Cabbage..	5 traps	5 traps	5 traps	
May 22-27, inc.....	86 22	17.2 4.4	17.2 4.4	

The number of traps is the total gained by considering one trap set one day as one, two traps in one day two, one trap for two days two, etc.

TABLE II.

DURABILITY OF ATTRACTIVENESS.

		May												June				
		16	17	18	19	20	21	22	23	24	25	27	30	1	3	5	7	10
Residue Honey Yeast Water	Female	15	10	7	13	5	11	11	29	23	36	61	16	10 —	20	5	32	1
	Male	6	2	2	5	7	6	8	12	3	9	11	1	0 —	4	1	2	1
	Female	..	..	..	..	3	13			discontinued			14	7	1	0 —	5	3
	Male	..	..	..	..	1	4	..	..	..	..	..	5	3	0	0 —	3	1
	Female	..	..	..	..	..	..	..	..	..	..	..	23	29	3	0 —	7	14
	Male	..	..	..	..	..	..	..	..	..	..	..	8	3	0	0 —	3	7
Cabbage Honey Yeast Water	Female	7	5	5	11	4	7 —	23	13	5	4	6 —	31	19	4	11	..	..
	Male	7	3	2	3	2	3 —	10	5	1	1	2 —	8	4	0	2	..	..
	Female	..	..	..	..	2	5			discontinued			33	18	4	10	..	..
	Male	..	..	..	..	2	10	..	..	..	..	..	3	1	1	3	..	..
	Female	..	..	..	..	..	..	..	..	..	..	..	41	37	6	14	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	6	21	0	0	..	..
Residue	Female	..	..	..	..	0	0 —	2	21	12	4	24 —	33	45	14	15 —	18	6
	Male	..	..	..	..	0	1 —	2	13	3	2	6 —	9	8	0	3 —	2	4
	Female	..	..	..	..	1	2	discontinued		1	7	17 —	4	12	0	1 —	2	2
	Male	..	..	..	..	0	0	..	..	0	1	9 —	3	2	0	2 —	0	0
	Female	..	..	..	..	..	..	..	..	..	..	..	22	13	4	..	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	10	7	0	..	..	..
Extract	Female	..	..	..	..	5	5 —	18	30	10	1	19 —	20 —	12 —	3	..	..	..
	Male	..	..	..	..	6	6 —	10	20	2	1	3 —	1 —	2 —	0	..	..	..
	Female	..	..	..	..	11	2 —	9	14	2	3	1	..	..	..	..	..	..
	Male	..	..	..	..	9	2 —	9	6	0	0	1	..	..	..	..	..	..
	Female	..	..	..	..	..	..	17	70	13	7	7 —	19 —	17 —	0	..	..	..
	Male	..	..	..	..	..	..	14	16	3	0	0 —	4 —	7 —	1	..	..	..
	Female	..	..	..	..	..	..	..	..	..	..	..	7 —	12 —	3	..	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	1 —	4 —	1	..	..	..

Each time the bait was renewed is indicated by a dash (—), except when water alone was added. Each line (male and female) gives results of one series with one trap.

EXPERIENCES IN DUSTING TO KILL PEA APHID, CABBAGE APHID, AND ONION THRIPS.

R. B. Friend and B. H. Walden.

The following experiments were carried on to determine whether or not nicotine dust (commercial brands containing 2.75 per cent. nicotine and 3 per cent. nicotine) would kill the insects in question. In all these experiments a rotary hand duster was used. Some of the dusting was done at the Experiment Station Farm at Mount Carmel, and some was done at other farms in the State.

The cabbage aphis, *Brevicoryne brassicae* L., when infesting cabbages to any great degree, causes the leaves to curl and checks the growth to such an extent that solid heads do not form. At the farm of Mr. E. M. Wooding at North Haven, one application of 3 per cent. nicotine dust at the rate of 50 pounds per acre (applied by Mr. Wooding) practically eliminated the aphids. The dust was applied on a two-acre plot between 7:00 A.M. and 1.00 P.M., July 26, 1924. The infestation had progressed to the extent that some of the leaves had curled. Experiments at the Station Farm where the infestation was somewhat lighter showed a good control with 2.75 per cent. nicotine dust. Dusting should be done as soon as the aphids appear in small numbers on the plants and before the leaves are curled, when a lighter application than the above would probably give equally good results. If the leaves have curled, it will require more time to make the application, as the nozzle of the duster should be inserted into the curled leaves to reach the aphids thus protected. The best time for dusting seems to be in the late afternoon of a warm, quiet, clear day.

The pea aphis, *Illinoia pisi* Kalt., was only locally abundant around New Haven in 1924. A badly infested field of garden peas situated near the Station was treated with a very heavy application of 2.75 per cent. nicotine dust on June 25, 1924, at 10:00 A.M. The temperature was about 82° F., and the day clear. A rather strong south wind was blowing. The vines were well grown, the peas being almost ready to pick, and the infestation was very heavy. Dust was applied at the rate of about 140 pounds per acre, and a count of aphids was made the following day. This count was made from three random samples from the dusted area and three random similar samples from the undusted area. The dusted plants had 181 live aphids, against 1,663 on the checks, 89 per cent. being killed. As this application of dust was much heavier than would ordinarily be applied, recommendations as to control cannot be made from this experiment. Further work will be carried out along this line. In Maryland, experiments of Cory and Potts (Univ. of Maryland Agr. Expt. Sta., Bulletin 261, February, 1924) where large areas were dusted with power dusters, show that 5 per cent. dust at not less than 30 pounds per acre will give an economical control

when applied with the aid of a long trailer. For details, see their bulletin. The pea aphid and the hand duster in operation are shown on Plate XXXI, b and c.

The onion thrips is difficult to control because there are always many individuals down in the sheath of the leaf protected against the treatment. A heavy application of 2.75 per cent. nicotine dust was applied to Ebenezer onions (sets) at the farm of W. S. Morris & Company in Wethersfield on July 16, 1924. The dust was applied at 2:00 P.M. The day was fair and warm, and the wind fairly strong. A count of thrips from dusted and untreated areas showed little control, if any, with the dust. The onions were well grown (about 15 inches high), and the infestation of thrips heavy. On July 21, the above plot was again dusted, together with an additional untreated area. This application was at the rate of 200 pounds per acre and was applied at 3:00 P.M. The day was fair and warm, and a rather strong west wind was blowing. On July 24, random samples were taken from the untreated and treated areas. As field observations showed the dust killed the thrips which were on the exposed parts of the leaves, that is, not in the sheath; the plants examined were cut one inch above and one inch below the sheaths and thrips counted in this sheath area only. The plants from the check area (untreated) showed 551 thrips as against 291 for the area dusted once and 98 for the area dusted twice. However, the lowest count plant from the check area had fewer thrips than the highest count plant from the area dusted once. All the plants dusted twice had a small number of thrips in the sheath.

Plots of young onions (6 inches high) in the Station garden at New Haven were dusted under favorable conditions July 25 and July 28, 1924. Field observations indicated that there were many live thrips in the sheath of the leaves, although those on the exposed parts of the leaves were killed. Apparently 2.75 per cent. nicotine dust, even though in excessive quantities, will not fully control the onion thrips when applied with a hand duster as above. Further experiments will be conducted with nicotine dust on this insect.

In dusting vegetables for aphids, the dust should be applied late in the afternoon and if possible when there is no breeze blowing. *The temperature should be high, above 70° F., for* good results. Dusting should not be delayed until the infestation is severe enough to wilt or curl the leaves, as even a heavy application of dust will then give less satisfactory results than a light application put on when the insects are not very numerous. Higher concentrations of nicotine in the dust as a rule will give better results than lower concentrations, other things being equal, and less dust will be required.

From our observation with the majority of hand dusters, it is necessary to use a larger amount of dust to cover the plants thoroughly than is required with a power duster that drives the dust with greater force into every part of the plant.

HINTS ON PHOTOGRAPHING INSECTS[1]

B. H. WALDEN.

It is rather difficult to know just what will be of interest to this gathering regarding insect photography, as some of you have had considerable experience in photographic work while others may have no occasion to take pictures.

In general, photographing insects is somewhat similar to making portraits; it is necessary to arrange a miniature studio and follow the same principles in lighting, exposure, etc. So instead of strictly following the subject, I am planning to take up certain points regarding which there has been more or less inquiry by different ones who are interested in insect photography.

The question of lenses is one that has probably received more attention than any other. Many are puzzled to understand why

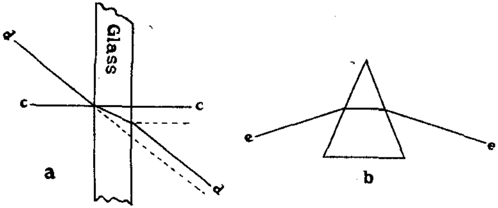

Figure 8. a. c. c. represents a ray of light passing from air through a plate of glass at right angles to its surface; d. d. a ray of light bent in passing from air through glass when entering the surface at an oblique angle. b. e. e. Showing the way that a ray of light is bent in passing through a prism.

a photograph taken with a cheap single lens may be apparently as good as one made with an expensive anastigmat lens. Frequently the dealer is not clear in explaining the limits of the different types of lenses, and often overrates the advantage of the anastigmat lens.

In order to point out the development of the photographic lens, it is necessary to consider some of the first principles in optics.

We see objects by the light that is reflected from their surfaces. The surface of the object can be considered as being made up of an infinite number of points, each of which is reflecting rays of light, and the function of the photographic lens is to gather as many as possible of these rays and transpose them onto the plate or film in such a manner as to form a reproduction of the object.

[1] Paper read before the meeting of Connecticut Entomologists, New Haven, October 31, 1924.

A ray of light travels in a straight line as long as it continues in the same medium, such as the air, and will continue in a straight line if it passes from the first medium into another medium of the same density. If the ray of light passes from one medium to another of different density, i. e., from air to a plate of glass, and enters the latter at right angles to its surface, it will still continue in a straight line (see Fig. 8a, c.c. = a ray of light entering at right angles), but if the ray of light enters the glass at an oblique angle, it is bent away from a straight line. Upon leaving the glass and again entering the air, the ray will be bent parallel to the direction to which it entered (see Fig. 8a, d.d.). The ray of light when entering a denser medium is bent toward the normal (represented by c.c. Fig. 8a.) and when passing from denser medium to a rarer one is bent away from the normal.

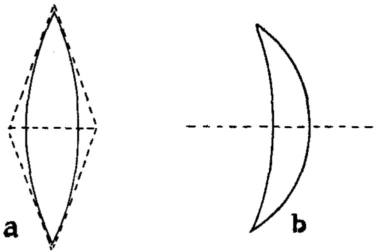

Figure 9. a. Showing the shape of a lens designed from prisms placed base to base; b. A meniscus lens, the simplest form of photographic lens, made from a single piece of glass.

This bending of light rays is called refraction and the degree of refraction depends upon the difference in density of the media and the angle at which the ray enters a different medium. According to the laws of refraction, if a ray of light is passed through a prism, the rays of light will be bent as shown at e.e. Fig 8b. If two prisms are placed base to base as shown in Fig. 9a. we have the principle upon which a simple lens is constructed, although the lines of the lens must be curved; every portion of the surface of a lens is a perfect arc of a circle. A lens of this form, however, is not suitable for photographic purposes. Fig. 9b. shows in cross-section the shape that the simplest photographic lens made from a single piece of glass must be constructed. This is known as the meniscus lens, so called from the crescent shape.

If such a lens is placed in a camera and an object is focused

on the ground glass and photographed, the negative will not be sharp. The reason for this is as follows. When light is passed through a prism, in addition to the bending of the rays as is shown in Fig. 8b., they are separated into the various colors of which the white light is composed. Each of the colors have a different wave length, red and yellow having the longest come at one end of the scale, and the violet and blue with the shortest wave lengths are at the other (Fig 10a.). Furthermore, the yellow rays are the "visual" rays or the ones by which we see the object on the ground glass, and the violet rays are the "chemical" rays or the ones which effect the sensitive film, so that when we focus such a meniscus lens, the ground glass will be in a plane of the yellow rays back of the plane of the violet and blue rays (see Fig. 10a, C. P. and V. P.

It is not possible to make a lens of a single piece of glass that will bring the yellow and violet rays into the same plane. This

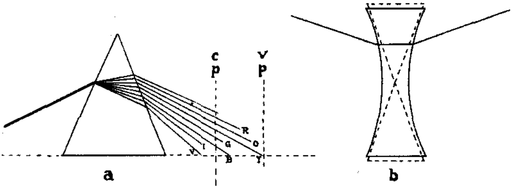

Figure 10. a. A ray of light separated by a prism into the principal colors of which it is composed; v. p., the visual plane and c. p., the chemical plane. b. A negative lens designed from two prisms placed tip to tip, showing the direction a ray of light is bent.

fault is known as chromatic aberration. These lenses are used, however, in some of the cheapest fixed focus box cameras by placing the lens so that the chemical rays will focus on the plate or film.

If a lens is designed from two prisms placed with the points together instead of the bases, the rays of light would be bent out or diverge instead of being bent in or converging as with the latter (Fig 10b.). The converging lens is also called a positive lens and the diverging lens a negative lens.

By using two kinds of glass of different density and combining a converging and diverging lens (Fig. 11a.), it is possible to bring the focus of many of the visual and chemical rays into the same plane. This type of lens is known as an achromatic meniscus. While this lens is a decided advance over the simple meniscus lens, it is not possible to control the rays of light at the edges

of the lens, so that it is necessary to cut out these rays with a stop, and use only those rays coming through the central portion. If we photograph an object with straight lines, such as a window, placing the stop behind the achromatic lens, the lines at the edges of the window in the photograph will curve outward (Fig. 12a.) If the stop is placed at the front of the lens, the edges will curve inward (Fig. 12b.) By combining two of these lenses with the concave surfaces toward each other and placing the stop between the two, this defect will be overcome and the lines will be straight in the photograph (Fig. 12c.) Such a lens is known as a rectilinear lens (Fig. 11b.) More of the marginal rays can be controlled in a rectilinear than in an achromatic lens, and a stop with a larger opening may be used, which admits between three and four times as much light as the single lens. The rectilinear lens, while satisfactory for many kinds of work,

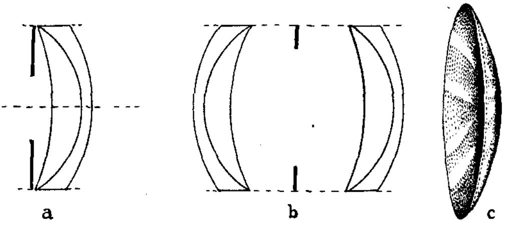

Figure 11. a. An achromatic lens, consisting of a positive and negative component; b. Construction of a rapid rectilinear lens; c. Diagram illustrating curvature of field of rectilinear lens.

still has many defects. The chromatic aberration is not entirely eliminated. If the image on the ground glass is focused sharply at the center, the edges of the field will not be sharp, showing that it is more or less saucer-shaped (Fig. 11c.). This is known as curvature of the field. In addition to this, some of the marginal rays cross those entering through the central portion of the lens and fall on the plate or film at an angle causing a slight blurring of the image. This defect common to the rectilinear lens, is spherical aberration and can only be corrected by using a smaller stop, eliminating the marginal rays and increasing the exposure. In photographing geometric figures or objects with both vertical and horizontal lines with a rectilinear lens, only one series of lines can be sharply focused, due to astigmatism.

Up to about 30 years ago, only two kinds of glass were available for making lenses: crown glass and flint glass. These were

of different density and therefore each would bend the rays at different angles. Positive lenses or elements were usually made of crown glass, and the negative elements of flint glass. Only a certain degree of skill was required to reduce the principal defects, curvature of the field, chromatic and spherical aberration and astigmatism to the limit obtainable with these glasses.

About this time, a new kind of glass was produced which could be made in different degrees of density, and lenses could be made in which the above mentioned defects could be practically eliminated. This is the Jena glass from which the anastigmat lenses are made. These lenses could be further corrected for certain other faults which are essential in certain critical lines, but of little importance to the ordinary workers.

In the anastigmat lens, it is also possible to bring the light rays entering near the margin of the lens into the same plane as

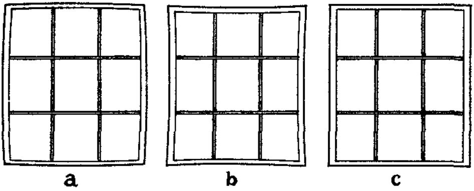

Figure 12. a. Diagram of a window sash showing distortion with the stop behind a meniscus lens; b. The same with the stop in front; c. Lack of distortion when made with a rectilinear lens.

those nearer the center, so that it is not necessary to "stop" them out. For this reason, from 40 to 300 per cent. more light, depending upon the construction, will pass through these lenses than through the rectilinear lens. While the anastigmat lens is comparatively free from optical faults, it is only by using great care in the construction that the defects found in other types of other lenses can be eliminated. The lens glass will vary in density with the amount of heat used in fusing it, and the lens formula must be computed for each lot of glass. The elements are ground and polished to within at least one thirty-thousandths of an inch. This grinding has to be done slowly so as not to heat the glass and cause it to expand. Anastigmat lenses may have from three to 10 glasses in their construction (see Fig. 13) and it is not hard to see why they may cost from five to 10 times as much as rectilinear lenses.

The size of a photographic lens is based on what is known as the focal length. This is approximately the distance from the

ground glass or film to the center of the lens, when it is focused on an object at a distance of 100 feet. Cameras for general work are usually fitted with a lens, the focal length of which is equal to, or slightly shorter, than the diagonal of their plates or films: for example, a 3¼ x 4¼ camera with a diagonal of 5.3 inches will have a lens of about 5¼ inches. Fig. 14 gives the diagonals and focal lengths of lenses for three common sizes of cameras. A lens of shorter focal length will give an exaggerated prospective; that is, nearby objects will appear too large and distant objects will be proportionately small. A lens of a focal length longer than the diagonal of the plate will often give a better prospective, but would be too large to fit the average small hand camera. It is also necessary in photographing large objects,

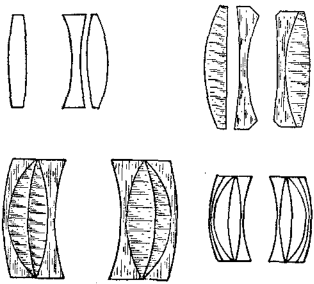

Figure 13. Diagrams of the construction of anastigmat lenses, with from three to ten glasses.

such as buildings, to stand further away to include as much in the view as is done with the shorter focus lens.

Lenses are provided with stops to cut down the size of the aperture. There are two systems in general use, both of which are based on the focal length of the lens. In what is known as the "f" system, the diameter of the opening is a fractional part of the focal length; that is, if the largest stop or opening of an eight inch lens is one inch in diameter (one-eighth of the focal length), it would be marked "f.8" which also indicates the speed of the lens and would be called an f.8 lens. The diameter of each of the smaller stops would be indicated by their fractional value as f.11 (one-eleventh), f.16 (one-sixteenth), etc.

In the other system, called the uniform system (U.S.), the equivalent of f.8 is designated as 4, and the number for each smaller stop is twice that of the preceding and indicates that the

exposure should be doubled. This system is generally used with rapid rectilinear lenses, while stops of anastigmats are usually marked with the f. system. The relative stop values of these systems are given below.

F. System.......	f.6.3	f.8	f.11	f.16	f.22	f.32
U. S. System.....	$2\frac{1}{2}$	4	8	16	32	64

Anastigmats are frequently termed "fast lenses" and the novice may get a wrong impression of what is actually implied by this term. The amount of light which passes through a given sized opening of a meniscus lens, say stop f.16, which is usually the largest stop of this type of lens, is exactly the same as will pass through an anastigmat at f.16. The exposure would be the same for either lens, as the amount of light that can enter to affect the film depends simply upon the relative area of the lens opening.

As has been stated, the largest stop of the single lens is usually

SIZE	DIAGONAL	LENS
$3\frac{1}{4}$ X $4\frac{1}{4}$	5.3 in.	$5\frac{1}{4}$ in.
4 X 5	6.4 "	6 "
5 X 7	8.6 "	$8\frac{1}{4}$ "

Figure 14. Three sizes of cameras, their plate diagonals and the focal length of lenses often used on each.

f.16; that of the rectilinear lens is f.8, twice the diameter of the former, and thus admitting four times as much light. The largest aperture or stop of the anastigmat may be larger than f.2, or the diameter of the lens opening more than one-half the focal length of the lens.

Anastigmats fitted to hand cameras, however, rarely have an opening of more than f.6.3, which admits a little over 60 per cent. more light than the rectilinear lens.

In using these large apertures, or in other words, giving a short exposure with the lens wide open, we lose something that is of extreme importance in scientific photography; the depth of focus. The depth of focus is the degree of sharpness of objects in different planes, or distant and nearby objects in the view that we wish to photograph.

This is a fixed quality in all lenses regardless of the type. Depth of focus depends upon two things; the size or focal length of the lens, and the size of the stop used. The longer the focal length, the less depth; the larger the stop, the less depth.

If we take a 3¼ x 4¼ camera with a f.6.3 anastigmat lens and make a photograph with lens wide open and the distance set for 50 feet, objects from 29 feet to a distance of 170 feet should be sharp. If we make a duplicate photograph, stopping the lens to f.16, objects from 18 feet to infinity, or far as the view extends, should be sharp. Any other 5¼ lens, whether meniscus or rectilinear with stop f.16 will give exactly the same amount of depth and the exposure for all of these lenses will be the same. If, then, we wish to take advantage of the so-called speed of the anastigmat lens, we can only do so by opening up the stops to let in more light and thereby sacrifice the depth of focus in the picture. Fig. 15 shows the relative sized stops of a 5¼ inch lens, with the required exposures and the depth of focus with each stop when the camera is set for 50 feet.

To the average worker, the principal advantage of the anas-

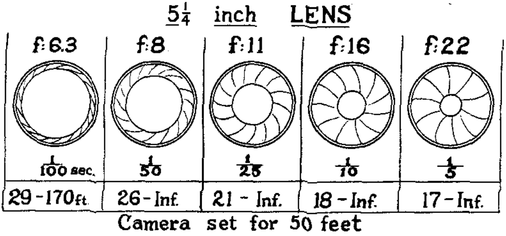

Figure 15. Relative size of the diaphram opening of a 5¼ inch lens with the relative exposures and depth of field with the camera set for fifty feet.

tigmat lens over the rectilinear are the flat field which insures negatives sharp to the edges even when used wide open, and the larger apertures which allow for shorter exposures under unfavorable conditions, although some of the depth must be sacrificed. In general these lenses should be used just the same as a rectilinear.

The loss in the depth of focus with large apertures is more apparent in longer focus lenses such as are used on 5 x 7 to 8 x 10 cameras. This is one advantage in using a small camera for field work. With care in focusing or in using the focusing scale for the principal objects, reasonably sharp negatives can be made with lenses up to the 3¼ x 4¼ size when used wide open. Unless actually cloudy, this will allow exposures of one-hundredth of a second at f.6.3 when photographing spraying operations and similar operations that require a short exposure in order that the movement does not blur the picture.

For photographing insects and their work in the laboratory, it is necessary to have a larger camera with a long bellows. While there are a number of cameras designed for photo-micrograph work, there is no camera on the market that is entirely satisfactory for photographing insects from natural size up to eight or 10 diameters. In our work, we use a 5 x 7 view camera mounted on a stand that allows the camera to be used either in a vertical or horizontal position.

A lens of about four inch focus is used in photographing insects natural size or twice natural size. This requires a bellows extension of twice the focal length for natural size and three times for twice natural size, or eight and 12 inches respectively. In photographing insect eggs or similar small objects, it may be necessary to make the direct photograph six to 10 times natural size. To do this with the four inch lens, it would require a bellows length of 44 inches for the 10 times enlargement; as the camera has only a 22 inch bellows, we use lenses such as are used on motion picture cameras with focal length of only one and one-half or two inches.

The question naturally occurs, how can we use these small lenses designed to use on a film only a little larger than a postage stamp to cover a 5 x 7 plate. We are simply converting the short focus lens into a long focus lens and bringing the object to photograph very near to the lens. As soon as we do this, the values of the stops in the lens are changed in relation to the focal length and the exposure has to be greatly increased in proportion to the given enlargement. If the exposure for natural size is expressed as 1, the increase in exposure for various sized enlargements is as follows:

Times Enlarged...	1	2	3	4	5	6	8	10	12
Exposure........	1	2¼	4	6	8	12	20	30	42

We are using cut films instead of glass plates in most of our work. *Regardless of the argument that the films do not lie flat* and are inferior to plates, I feel that we are getting equally good results with the films and they have a number of advantages over the plates. Halation is reduced to a minimum and there is no danger of breakage. They are much lighter in weight and about 25 can be stored in the same space as a dozen plates. Panchromatic films with a set of color screens to be used with them are desirable to bring out colors that will not show contrast on regular or even Orthochromatic films.

In photographing insects or their work in the laboratory, the material is placed on a piece of ground glass with the background two or three inches below to eliminate the shadows. From an artistic standpoint shadows may add to the photograph, but they often detract from and add confusion to scientific photographs which should be as simple and clean cut as possible. The back-

ground is usually a piece of white cardboard, although various tints of gray are used to bring out contrast with light-colored or white objects. Pieces of white cardboard are also set up for reflectors to light the shaded side of the object.

The chief requisite in photographing caterpillars is patience. As a rule the specimens will appear natural only when photographed alive. Better results can be obtained with one to three specimens than where more are included. When possible the specimens should be placed on some of the food plant which shows characteristic work of the species. The food plant must lie as flat as possible, and twigs or leaves out of the general plane should be removed as they will be out of focus in the photograph. Most of the caterpillar photographs are made natural size as enlarging them would require too long an exposure. The lens should be stopped down as much as possible, depending upon the activity of the insects. As we use daylight for most of the exposures, it requires from five to 10 seconds with f.8 stop; more often a smaller stop is used. With the specimens focused and the cap over the lens, the slide is drawn from the plate holder. It is then a case of watching and waiting for the specimens to become still for the required exposure.

Slightly pinching a caterpillar or tapping it with a pencil will sometimes cause it to remain quiet. In some cases it is necessary to stupify the specimens with chloroform but this should only be done when they will remain quiet in no other way.

There are many occasions to make illustrations of adult insects from dead specimens. Though there has been some controversy as to whether the specimens appear more natural to the average person if symmetrically set or photographed without such preparation, in either case a specimen will not appear as in nature and the writer feels that an illustration of an insect is more satisfactory if it shows all six legs than when it gives the impression of having but one or two.

It is often desirable to show butterflies and moths with the wings folded in a resting position. Large specimens can often be photographed alive in a characteristic resting position. Where we wish to show the wing-spread and especially the under wings, carefully set specimens make much better photographs than those set in a careless manner. Pinned specimens are usually set in a piece of cork covered with white paper. Where possible it is well to cut off the head and portion of the pin above the insect close to the body.

In making enlarged photographs of small insects, it is often difficult to focus the object due to a certain amount of play in the camera adjustments. To overcome this an ordinary dissecting microscope has been fitted with a glass object carrier on the lens arm. The object to be photographed is placed on this, the camera bellows set for the right magnification and the object

brought into the focal plane by using the rack and pinion of the dissecting stand.

The exposures in insect photography should be fully timed. If the detail is present in the negative, sufficient contrast can often be obtained with the proper grade of photographic papers. Satisfactory prints, however, cannot be made from under-exposed negatives; if the detail is lacking there is no way to supply it and if possible another negative should be made.

Good insect photographs after all depend largely upon the experience of the operator and his ability to use the available apparatus and materials to the best advantage.

MOSQUITO CONTROL WORK IN CONNECTICUT.

Season of 1924.

R. C. BOTSFORD.

The Director of the Connecticut Agricultural Experiment Station is charged by Statute with the maintenance of drainage works for mosquito elimination, inspected and approved by him. He may also upon request inspect and survey mosquito breeding areas, furnish estimates of cost of treating these areas and supervise or regulate the work. The area of 5,000 acres of ditched salt marsh under State maintenance and contained in nine shore towns was patrolled from April 1 until October 1. Ditches were kept free from obstructions and when found in bad condition, were recut and graded as far as funds would permit. About 155,000 lineal feet were recut. As a result there were but few spots where salt marsh pools would have remained long enough to develop adult mosquitoes. In such cases, oil was sprayed on the pools at the proper time.

The inland or fresh water work is at present limited to making investigations of mosquito infested areas upon request. In such instances, practical advice is given concerning the elimination of each particular breeding place.

Mosquito control work has been generally successful this season and there has been a notable increase of interest shown throughout the State in the mosquito problem.

The expenditures for the year 1924 were as follows:

New work and maintenance work supervised by the State where funds were provided by individuals, associations or towns:

Fairfield	$3,556.97	
Stamford	1,300.00	
Westbrook	1,080.00	
		$5,936.97
Maintenance work in 9 towns (State funds)	5,019.95	
Supervision, tools, etc. (State funds)	2,734.75	
		7,754.70
Total		$13,691.67

The following table shows the present condition of the salt marsh areas in the coast towns. It was prepared from data immediately available and is subject to correction.

Town	Salt Marsh Acres	Salt Marsh Ditched	Maintained by State	Total Cost of Ditching	Labor, Cost of Maintenance 1924	Labor, Cost to Complete
Greenwich	....	....	None	....	....	....
Stamford	300	300	200	$2,800.00	$236.00	....
Darien	300	300	None	3,800.00	....	....
Norwalk	600	600	None	7,500.00	....	....
Westport	350	50	50	Ditched with Fairfield	....	$5,000.00
Fairfield	1,200	1,200	1,200	8,400.00	900.00	....
Bridgeport	173	....	....	....	....	3,000.00
Stratford	1,315	....	....	....	....	16,000.00
Milford	630	....	....	....	....	8,000.00
West Haven	463	222	222	Ditched with New Haven	194.00	3,500.00
New Haven	750	750	750	12,000.00	592.50	....
Hamden, North Haven	2,042	....	....	....	....	25,000.00
East Haven	482	150	50	Ditched with New Haven	42.75	6,500.00
Branford	895	578	578		787.55	4,500.00
Guilford	1,085	1,085	1,085	20,000.00	545.52	....
Madison	1,005	1,005	1,005		1,674.43	....
Clinton	766	....	....	....	....	10,000.00
Westbrook	500	90	None	1,517.61	....	5,000.00
Old Saybrook	1,373	60	None	....	....	17,000.00
Lyme	493	....	....	....	....	7,000.00
Old Lyme	1,393	....	....	....	....	17,000.00
East Lyme	424	....	....	....	....	5,000.00
Waterford	204	....	....	....	....	3,000.00
New London	34	....	....	....	....	500.00
Groton	304	50	50	1,000.00	47.20	4,000.00
Stonington	555	....	....	....	....	7,500.00
Totals	17,636	6,440	5,190	$57,017.61	$5,019.95	$147,500.00

The Work by Towns.

New Haven.

The town of New Haven contains about 750 acres of salt marsh, all of which was ditched for mosquito elimination during the period from 1912-1917. These salt marsh areas were patrolled continuously from April 1 to October 1, and about 20,500 lineal feet of ditches found in bad condition were recut and graded. Some breeding was discovered where drainage was not yet perfect, but oil was sprayed on the water at the proper time to prevent emergence. There was practically no emergence of mosquitoes from the salt marshes in the town of New Haven in 1924. In spite of this fact, New Haven was more or less infested with salt marsh mosquitoes throughout the summer. This was

due to mosquitoes migrating from breeding places in bordering towns.

It is recommended that a tide gate be placed in Little River at Middletown Avenue.

West Haven.

The salt marshes in the town of West Haven seem to furnish the principal salt marsh mosquito nuisance in New Haven. There are yet about 250 acres of marshes in this town which have not been ditched for mosquito elimination, and in some of these areas breeding places exist throughout the season. A sluiceway with tide gate should be installed in the outlet of the Old Field Creek, extending from Beach Street about 300 feet into the bay, and the creek dredged from Beach Street to Peck Avenue. At times the creek and marsh become so heavily polluted that the killy-fish, the natural enemy of the mosquito, either perish or are driven back into the bay. Mosquitoes breed here in immense quantities. This public nuisance is entirely unnecessary and should be abated.

East Haven.

There are about 482 acres of salt marsh in this town. About 150 acres of this have been treated for mosquito elimination and were kept free from breeding throughout the season. The remaining 332 acres should be treated before relief from mosquitoes can be expected.

The State rifle range was inspected on April 15. Every depression in the wooded area was holding water and breeding mosquitoes. Later in the season when the ranges are in use, these mosquitoes are very troublesome. It is then too late to do anything about it. These breeding places should be filled where practical, or drained or oiled during April, May and June.

Branford.

More than 17,000 lineal feet of ditches were recut and graded in this area since the fall of 1923. A 20 x 24 inch ditch about 400 feet long was dug at Sunset Beach to simplify a drainage problem there. The marsh area under State supervision was thoroughly patrolled throughout the season, and all ditches kept free from obstructions. There was no salt marsh mosquito breeding in this area.

The drainage of the Sybil Creek marsh north of the tide gates on the Indian Neck Road could be improved by a new tile outlet about 400 feet long running eastward and emptying directly into Long Island Sound. More than 317 acres of salt marshes in Branford are not ditched or treated for mosquito elimination.

Guilford.

Drainage of the salt marsh areas of this section was well maintained throughout the season. A reported abundance of mosquitoes in one locality led to the discovery of a small corner of salt marsh which will require additional ditches. Repair work was begun on the stone dike at Shell Beach; 25 lineal feet of wall was rebuilt, and this will be continued as funds become available.

Madison.

Mosquito breeding in Madison was well controlled. Over 8,000 feet of ditches were entirely renewed in the Hogshead Point section. Seven corrugated iron culverts were installed in beaches to replace wooden structures destroyed by storms, and one new 36 inch iron tide gate installed near East River on the Post Road. (See Plate XXXIV

At Hammonassett State Park, labor and oil were furnished by the State Park and Forest Commission to control the breeding in the salt marshes contained in and adjacent to the park. The area was thoroughly patrolled and oiled when necessary, and in addition, more than 43,000 feet of damaged ditches recut. A striking reduction in the number of mosquitoes in the park was reported, due to this work.

Westbrook.

The drainage work was started as soon as the weather permitted and continued until the funds were exhausted. This fall more funds were turned over to the Station to continue the work. The ditching of the Fisk marsh and Rushy meadow are practically completed. The culvert draining the Fisk marsh continued to function perfectly throughout the season. The Rushy meadow culvert was relocated and extended 50 feet. Ditching of the Patchougue River marshes near the center of the town was started on December 3 and discontinued on December 20, due to cold weather. Some reduction in the number of mosquitoes was reported this season.

Groton.

The small ditched area at Groton Long Point was thoroughly patrolled. Ditches were put in good condition by recutting and grading where necessary. No breeding pools existed. The bridge over the marsh outlet should be replaced or a culvert installed in its place.

Fairfield.

The town of Fairfield continues its interest in mosquito elimination and has co-operated with the State throughout the year.

The salt marshes were kept free from breeding the entire season by keeping the ditches cleared and oiling certain pools at the proper time. The fresh water work was continued under the same arrangement as last year, and the drainage work extended and improved. The Fairfield Improvement Association, the town, and individuals supply the bulk of funds for this work from year to year.

Stamford.

The Stamford salt marsh area under State maintenance at Shippan Point was well patrolled and the ditches kept open so that the marshes were well drained throughout the season. About 5,500 lineal feet of ditches were recut. No mosquitoes developed on this area. In the meantime, mosquitoes were reported breeding in Southfield marshes, Gourley Tract Swamp and other areas not under State supervision. Upon request of the Health Commissioner of Stamford, an estimate of the cost of treating these breeding places was furnished by the State. The work was started on July 1, and supervised by the State without charge. Eleven thousand feet of old ditches were recut, and 1,300 feet of new ditches and 500 lineal feet of tile and iron pipe were installed. (See Plate XXXIII, b.)

Fresh water breeding places were oiled, and several miles of fresh water ditches cleaned. A reduction in the number of mosquitoes has been reported.

. . . . .

The law passed in 1913, declaring mosquito breeding places a public nuisance and authorizing health officers to abolish them remains on the Statutes and is as follows:

Section 2408. **Mosquito breeding places; treatment.** Any accumulation of water in which mosquitoes are breeding is declared to be a public nuisance. When it has been brought to the attention of a health officer or board of health, through the complaint of any citizen, or when discovered by any inspector or agent of said health officer or board of health, that rain water barrels, tin cans, bottles or other receptacles, or pools near human habitations are breeding mosquitoes, it shall be the duty of said health officer or board of health to investigate and to cause such breeding places to be abolished, screened or treated in such manner as to prevent the breeding of mosquitoes. The health officer, or any inspector or agent employed by him, shall have the right to enter any premises in performance of his duties under this section.

NOTES ON MISCELLANEOUS INSECTS.

Miners in Milkweed Pods: Milkweed pods infested by larvae were collected in Manchester, August 14, 1924, by Mr. J. L. Rogers, Assistant, and were placed in the insectary. On September 27, an adult emerged and another one was obtained on October 25. The adult insect is a black weevil or snout beetle, *Rhyssematus lineaticollis* Say.

Walnut Bud Moth: On June 11, 1924, we received from Mr. B. M. Gillette, Taintor Hill, Suffield, some specimens of brown larvae infesting a Japanese walnut tree. This insect had prevented the owner from obtaining any nuts and is probably the walnut bud moth, *Acrobasis caryae* Grote, though it may prove to be some other related species. In 1912, we had no difficulty in holding this insect in check by spraying thoroughly with lead arsenate.

Sawfly on Arbor-Vitae: On July 10, 1923, Messrs. M. P. Zappe and J. L. Rogers, while in Manchester, noticed some sawfly larvae feeding upon small arbor-vitae nursery trees. A few larvae were found on each tree though no particular injury could be detected. The larvae were grayish green in color, without prominent markings. The material was placed in cages in the insectary and adults emerged on March 10, April 24 and May 22, 1924. Specimens were sent to Mr. S. A. Rohwer, who identified them as *Monoctenus juniperinus* MacGillivray, a species described in 1894 from material collected at Ithaca, N. Y.

Leaf-Roller on Pin Oak: In Fairfield County and in other parts of the State, pin oaks were attacked and in some cases nearly defoliated by a leaf-roller, presumably *Tortrix quercifoliana* Fitch. This insect was observed in New Haven where it caused slight injury, and in Greenwich and Stamford, where it was much more abundant. One pin oak growing naturally in a field north of Stamford was completely stripped by June 9, and is shown on Plate XXV, b. Probably a thorough spraying with lead arsenate would prevent such injury.

Biting Dog Louse in Connecticut: On April 11, specimens were received from Pomfret, of the biting dog louse, *Trichodectes latus* Nitzsch, which had infested a collie dog. The dog had been treated by a veterinarian without complete success. The owner was advised to shampoo the dog thoroughly with a miscible oil that will mix with water. Several treatments may be necessary to get rid of the pest, and a few hours after each treatment, the material should be removed by washing in clear water. This insect belongs not to the Parasitica but to the Mallophaga, and though it is supposed to be quite common, this is our first record of its occurrence in Connecticut.

The Azalea Scale: On June 23, a twig of rhododendron was brought to the Station from the neighboring town of Orange, and on the bark were many small white tufts, that resembled felt. This is the azalea scale, *Eriococcus azaleae* Comst., a species often found on shrubs of the heath family, Ericaceae, and occasionally on Crataegus or hawthorn. We have previously recorded the species from Hartford and New Haven. Both sexes are enclosed in a dense white felt-like sac, ovoid in shape. Should this scale become sufficiently abundant to cause injury, no doubt spraying with a miscible oil, or with nicotine solution and soap would free the plant from the scales.

Tropical Cockroach in Greenhouse: Several adult and immature cockroaches were received from Rowayton, on June 13. They were present in a commercial greenhouse where it had become quite a nuisance. The insect in question is *Pycnoscelus surinamensis* Linn., the same species that became a pest a few years ago in the rose houses of A. N. Pierson, Inc., Cromwell, Conn., by eating the bark from newly-set plants, an account of which has already been published.[1] It was found that the roaches would congregate under boards and in the corners of the benches where they could be surprised by a spray of clear kerosene which brought them to a quick death. Of course this spray must not come in contact with the foliage.

Spiny Caterpillars on Hollyhocks: During June, hollyhocks in the writer's garden were attacked by spiny caterpillars which fed upon the leaves. Some were killed by crushing but no poison was applied. On June 25, material was brought to the laboratory and some parasites were obtained. The species attacking hollyhock was the hop merchant butterfly, *Polygonia comma* Harris. The larva is nearly one and one-half inches in length when full grown and is dark brown on the back with two faint lighter median lines; below the spiracles and the entire ventral surface is light brown. Head and legs, dark brown, prolegs light brown. Each segment dorsally bears a transverse row of branched spines, and many hairs which are light brown. Two parasites emerged on July 8.

Sawfly Feeding on White Pine: Sawfly larvae on white pine were received on July 19 from Mount Carmel where they had defoliated several pine trees. The larvae were whitish, with black spots, and black heads. There were many pupae in the package and also many larvae which had contracted in size, preliminary to pupation. This material was caged in the insectary and on August 8, 13 adult sawflies and four parasites emerged. The species was formerly known as Abbott's sawfly, and occurs in literature under the name of *Lophyrus abbotti* Leach, but is now called *Neodiprion pinetum* Norton. It seems to be quite common

[1] Report Conn. Agr. Expt. Station for 1917, page 302.

in Connecticut and reports are received occasionally of small trees being stripped. Of course, spraying with lead arsenate will prevent defoliation.

Mealy Bug on Taxus: On April 30, specimens of mealy bug were received from Mr. Samuel Stewart, from the premises of Mr. Henry Osborn Taylor, Cobalt. The insects were on yew or Taxus trees growing out of doors. On June 13, more material was received from Mr. Taylor, and some of this was sent to Mr. Harold Morrison of the Bureau of Entomology, Washington, a specialist on scale insects. Mr. Morrison replied that the same scale had been received from Rutherford, N. J., on imported Japanese Taxus. At the time, it was identified as *Pseudococcus kraunhiae* Kuwana, but later Professor G. F. Ferris of Stanford University, Cal., showed that *kraunhiae* is something entirely different. Mr. Morrison has been unable to associate this material with any other described Japanese species, though possibly may later be able to do so. There is of course a possibility that this species has not been described. Shown on Plate XXXV, b.

The Bag Worm: A cocoon was received, May 1, 1923, of the bag worm, *Thyridopteryx ephemeraeformis* Haw., from a garden in New Haven. Eggs hatched in the bag May 11, and the tiny larvae immediately began to make bags for themselves from the leaves of the arbor-vitae twig on which the cocoon was fastened. Miss Finley observed their development and made notes. Some of the larvae tore off particles from the old bag for their coverings but others used green tissue from the leaves. The larvae molted five times inside their bags, which were then suspended by silk threads. Two adults emerged September 7, 1923. This insect, though common in New Jersey and southward, is seldom found in Connecticut unless brought in on arbor-vitae or some other food plant from the south. Occasionally, however, it is seen along the shore and may possibly survive the winters here in case they are mild.

Blue Elm Beetle in Branford: On June 20, I received from the Davey Tree Expert Co., Kent, Ohio, several small blue beetles, which one of their men, Mr. W. W. Tuomey, collected at the base of an elm tree on the grounds of Dr. A. J. Tenney, Branford, Conn. A report was sent to the firm, but on August 4, more specimens were received from Mrs. Tenney. These beetles were present in large numbers around the trunks of some trees close to the ground. This is the same species as has been received from other localities in years past as follows: Salisbury, feeding on elm and hickory, August 14, 1902; Old Saybrook, on elm, April 27, 1908; West Haven, on elm, September 11, 1922. This species is *Haltica* (or *Altica*) *ulmi* Woods, and has been confused with the strawberry flea beetle, *Haltica ignita* Ill., but was described in 1918 by Dr.

Wm. C. Woods as a distinct species.[1] Apparently it feeds upon the foliage of elm trees, but is never as abundant as the elm leaf beetle, *Galerucella xanthomelaena* Schrank (*luteola* Muller) though certain trees may be riddled. The same remedy will protect the trees, namely, spraying with lead arsenate.

European Pine Shoot Moth in Connecticut: On October 13, 1923, twigs of red or Norway pine, *Pinus resinosa*, were received from Dr. Arthur H. Graves, formerly of New Haven, who collected the specimens at Tarrytown, N. Y. The buds had been tunneled, and two brown larvae were present and were identified by B. H. Walden, Assistant Entomologist, as the European pine shoot moth, *Evetria buoliana* Schiff. On November 24, twigs of the same species also showing the work of this insect were received by Mr. W. O. Filley, Forester, from Mr. William Bunker, Ridgefield. On June 19, 1924, twigs of Austrian pine were sent to the Station by Mr. E. A. Jones, Superintendent, Waveny Farm, New Canaan. These had the characteristic crooked growth resulting from injury to the buds by this insect. According to Busck,[2] the larvae cannot be reached by the application of insecticides and the only means of control is to prune off and destroy the infested twigs and buds containing the larvae. This can best be done during the fall and winter.

A Beetle from Europe: On June 1, 1922, a letter was received from Dr. E. P. Felt, State Entomologist of New York, regarding a European beetle, *Heterostomus pulicarius* Linnaeus, which had been found in Albany, Columbia, Niagara, Rennselaer, and probably Essex Counties, in New York State, and which had caused some injury to strawberry blossoms and young fruit in one plantation in Columbia County. It had also been sent to Dr. E. A. Schwarz, Washington, from the Arnold Arboretum, Forest Hills, Mass. Just after receiving Dr. Felt's letter, Mr. H. C. Fall reported on some beetles sent him for identification, and among other things there was one specimen of *Heterostomus pulicarius*, collected at Milford, May 2, 1921, by M. P. Zappe. A note to this effect was published in the Journal of Economic Entomology, Vol. 15, page 311, August, 1922. The genus *Heterostomus* belongs to the family Nitidulidae, and until recently has not been reported from North America. According to Notman[3], it can be separated from *Brachypterus* as follows:

Claws distinctly toothed at base.
- Prosternum elevated at tip; elytral epipleurae distinct . . . . *Brachypterus*
- Prosternum not elevated at tip; elytral epipleurae indistinct . . . . *Heterostomus*

[1] Bulletin No. 273, Maine Agr. Expt. Station, page 182, 1918.
[2] Bulletin No. 170, U. S. Department of Agriculture, 1915.
[3] Journal New York Entomological Society, Vol. XXVIII, page 30, March, 1920.

Pine Seedlings Nearly Girdled by Hylobius pales: On July 15, Mr. H. W. Hicock brought to the laboratory from some town in Massachusetts some natural white pine which had been nearly girdled, and which showed the characteristic work of one of the large weevils, *Hylobius pales* Herbst. This form of injury has been studied by Mr. H. C. Peirson[1], who finds that the beetle feeds chiefly at night, and eats off the bark from the stems and sometimes the twigs of young seedlings during May and the first half of June. The eggs are laid singly in the bark of freshly cut pine logs or roots of stumps where lumbering operations are being conducted and hatch in 10 to 14 days. The larvae burrow beneath the bark until they become full grown, which is usually about the first of September, when they pupate in cells beneath the bark, usually going into the sapwood about one-fourth of an inch. The adult beetles emerge in the fall, some as early as September 15, and begin to feed upon the nearest pine seedlings. Most of them go into winter quarters in October. Control measures consist of burning the slash over the stumps in early spring, sawing the logs before the adults emerge, and stacking the lumber in open sunny areas where there are no young pine seedlings in the vicinity.

Western Corn Root Worm in Connecticut: On August 29, 1923, the writer collected in the flowers of marsh mallow, *Hibiscus moscheutos*, at Granby, Conn., two slender green beetles belonging to the family Chrysomelidae. A visit to the same place on September 5, 1924, showed that these beetles were quite common on aster, calendula and some other kinds of flowers in the garden and were feeding upon the petals. Mr. Zappe has identified this beetle as the adult of the western corn root worm, *Diabrotica longicornis* Say, a species which occurs in the Middle Western States, though apparently not previously recorded from Connecticut. It has recently been taken by Mr. K. F. Chamberlain at Cornwall, Conn. A brief note regarding the occurrence of this species in Connecticut was published in the Journal of Economic Entomology, Vol. 17, page 601, October, 1924. The beetles commonly feed on corn pollen and silk, and upon the flowers of squash, cucumber, beans, clover, goldenrod, aster, thistle and other blossoms. The larvae attack the corn roots, eating off the small roots and burrowing in the larger ones, doing considerable damage in the corn belt. So far as is known the larvae feed only upon corn, so a rotation of crops is recommended. It is impossible to foretell whether or not this insect will injure the corn crop in Connecticut. The appearance of the adult beetle is shown on Plate XXX, e.

A European Sawfly Leaf-Miner of Birch: During the summer of 1923, it was noticed in several localities in Connecticut that the

[1] Harvard Forest, Bulletin No. 3, 1921.

sprouts of gray birch, *Betula populifolia*, were attacked by a leaf-miner. The presence of this insect was observed at Rainbow in July during the summer meeting of the Entomologists of the Northeastern United States, and some material was collected and placed in one of the automobiles with a view to rearing the adult, but it was forgotten and became dry. Particularly were the mines noticeable in the terminal leaves of sprouts, but they were seldom present in the older leaves, the leaves on the lateral shoots, or on the larger trees. The larva makes a broad blotch mine often involving half and in some cases nearly the whole area of the leaf. During 1924, Mr. R. B. Friend, Assistant Entomologist of this Station, at my request, collected material and brought to the insectary for the purpose of rearing the adults. On August 6, he obtained a number of small sawflies of both sexes. Specimens were sent to Mr. S. A. Rohwer of the U. S. National Museum, who identified the species as *Fenusa pumila* Klug, a European insect which up to this time was not known to occur in the United States. A brief note regarding the matter was published in the Journal of Economic Entomology, Vol. 17, page 601, October, 1924. Since then we have observed the work of the insect in many parts of the State, and Dr. Felt informs me that he has seen its work throughout eastern New York. The appearance of the mined leaves is shown on Plate XXXV, a.

Sawfly Larvae Defoliating Honeysuckle: On June 10, 1923, the writer noticed on Barnett Street, New Haven, a wire fence covered with climbing honeysuckle, *Lonicera* sp., the leaves of which had been mostly devoured. A hasty examination showed that sawfly larvae were responsible for the defoliation, and many were present and feeding. On June 15, 1923, Mr. E. M. Stoddard, Pomologist of this Station, brought to the laboratory additional specimens of the same kind of insect which he found feeding upon honeysuckle in Hamden. Two adults from the Hamden material emerged on March 24, 1924, and one adult from the New Haven material emerged on April 30. Both lots produced adults of the same species, which is one of the larger sawflies, *Abia americana* Cresson. The larvae are nearly an inch in length when full grown and are dull gray in color with yellowish dorsal and latero-ventral stripes. A row of black spots extends the entire length of the back in the middle of the yellowish stripe. Head, dark brown or black; legs, prolegs and ventral surface, yellowish. On July 18, 1924, larvae of this species were received from Mr. J. E. Hopkins of Thomaston, which had completely defoliated a cultivated bush honeysuckle in the village of Northfield. Another species, *Abia inflata* Norton, also feeds on honeysuckle, and on July 7, 1915, larvae were received from Dr. Williams, Bristol. Adults were obtained April 27, 1916. Of course spraying with lead arsenate is a simple remedy to prevent defoliation of honeysuckle shrubs and vines whenever these larvae become abundant and troublesome.

Rudbeckia "Golden Glow" Stripped by Sawfly Larvae: On July 11, 1924, the writer visited the truck farm of Mr. H. E. Baldwin, Bayberry Lane, Westport, in company with Messrs. M. P. Zappe, Assistant Entomologist, Dr. G. P. Clinton, Botanist, and W. R. Hunt, Graduate Assistant in Botany. While there, we noticed a bed of *Rudbeckia laciniata*, "Golden Glow," about 12 feet long and perhaps half as wide which had been stripped of its leaves by sawfly larvae. Most of the larvae had left the plants, but some remained and many were found crawling on the ground and in the grass near the flower bed. Mr. Zappe and I collected some material and carried to the insectary with a view to rearing the adults. The full grown larva is about three-fourths of an inch long, ground color light gray or dirty white with a darker gray median stripe, and a row of rather large black spots on each side about half-way between the spiracles and the median stripe. Around the spiracles there are small black dots, two on each thoracic segment and the last abdominal segment, and four on each of the other abdominal segments. Head, black on upper surface and more than half of face; lower portion of head, legs, prolegs and ventral surface of body, light gray or dirty white with yellowish tinge. Mr. R. B. Friend, Graduate Assistant in Entomology, visited the place on July 18, and collected more material and brought home some plants of golden glow upon which to feed the larvae. From all this material, only one adult has been obtained, and it emerged on August 15. This was sent to Mr. S. A. Rohwer of the U. S. National Museum, who identified it as *Tomostethus inhabilis* Norton, a species supposed to feed on pear. As there were pear trees near the golden glow, it is quite possible that a larva from a pear tree was collected with the others which were feeding on golden glow. The species causing the stripping is therefore uncertain, and it is hoped that more material may be obtained next season in order to settle the identity of the species. The larvae and defoliated plants are shown on Plate XXXVI.

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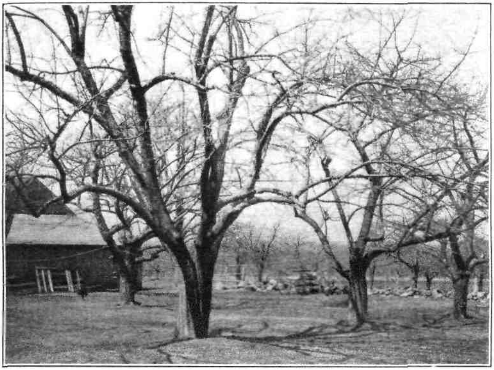
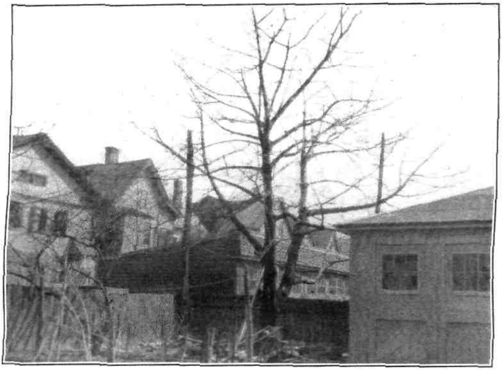


a. Infestation No. 1, Burlington, where 14 egg-clusters were found in this apple orchard. Photo April 10, 1924.

b. Infestation No. 5, Windsor, where 16 gipsy moth egg-clusters were found on willows. Photo April 10, 1924.

GIPSY MOTH INFESTATIONS.

PLATE XVIII.



a. The only infestation found in New Haven, on Howard Avenue, near the railroad bridge, on cherry and rose bushes, where six egg-clusters were found. Photo April 16, 1924.

b. Infestation No. 3, Granby, on white oak and cherry. Photo November 27, 1923.

GIPSY MOTH INFESTATIONS.

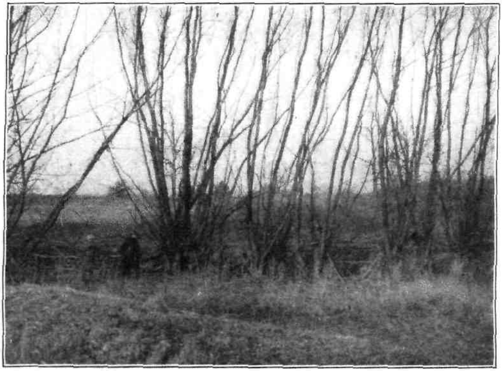
a. Infestation No. 6, Hartford, on North Meadows, near Windsor Line; 936 egg-clusters were found here. Photo March 26, 1924.

b. Infestation No. 5, New Britain Avenue, Hartford. Forty-two egg-clusters were found here on trees and on buildings. Photo, April 10, 1924.

GIPSY MOTH INFESTATIONS.

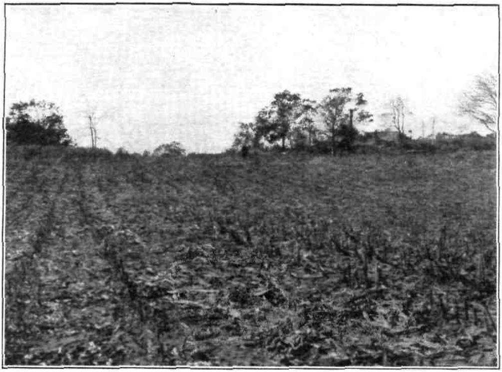
PLATE XX.

a. Infestation No. 14, Suffield, on willows in pasture. Photo November 27, 1923.



b. Infestation No. 17, Suffield. On this willow hedge surrounded by meadow land, 650 egg-clusters were found. *Photo November 27, 1923.*

GIPSY MOTH INFESTATIONS.



a. Bridgeport infestation, Hillside Home, showing stubble and weeds before burning.

b. Burning stubble in an adjacent field, Bridgeport.

EUROPEAN CORN BORER INFESTATIONS.

PLATE XXII.

a. New Haven infestation, showing broom corn which has grown from seed where clippings had been thrown on dump.

b. Broom corn clippings on dump along Peat Meadow Road, near Grannis Corner, New Haven.

EUROPEAN CORN BORER INFESTATIONS.

a. Infested garden in rear of broom corn factory, Townsend Avenue, Grannis Corner, New Haven, before burning.

b. Same as above; photo taken during the burning operations.

EUROPEAN CORN BORER INFESTATIONS.

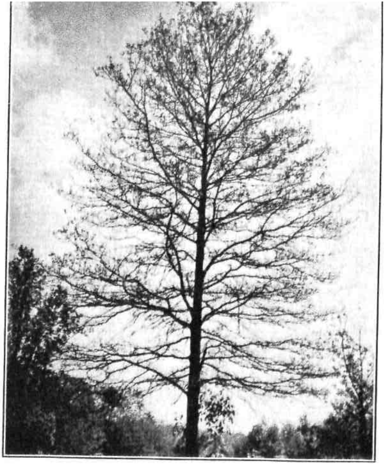
PLATE XXIV.

a. Method of distributing carbon disulphide emulsion on lawn infested with grubs.

b. Soaking down an infested lawn after applying insecticide to kill the grubs.

ASIATIC BEETLE INFESTATIONS.

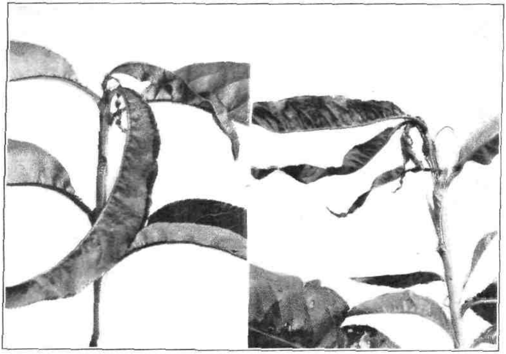
a. Asiatic beetle infestation. Applying cyanide with fertilizer drill.



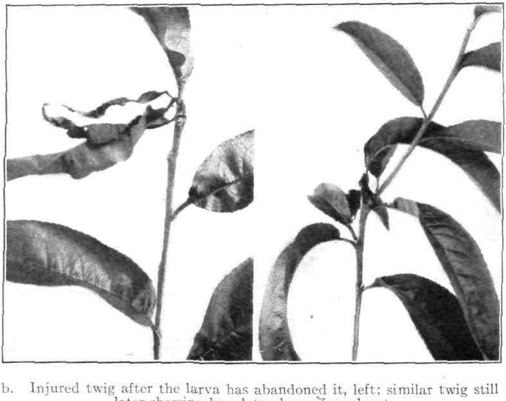
b. Pin oak nearly defoliated by oak leaf-roller.

ASIATIC BEETLE INFESTATIONS AND OAK LEAF-ROLLER.

PLATE XXVI.

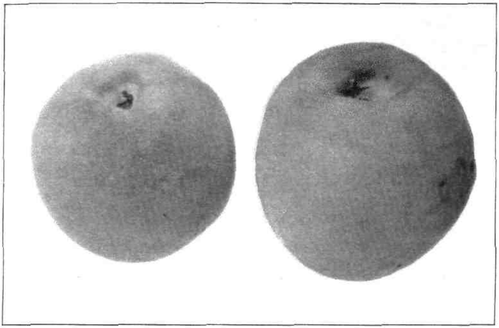


a. Newly infested twig, left; more advanced stage, right.

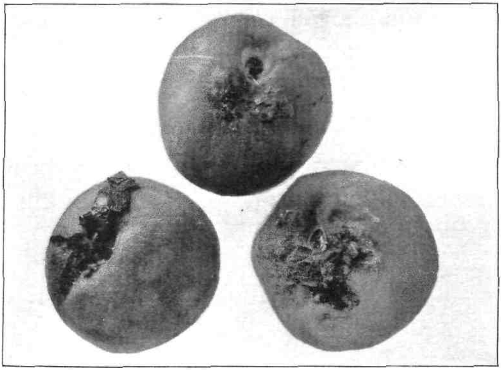


b. Injured twig after the larva has abandoned it, left; similar twig still later showing how laterals are forced out.

ORIENTAL PEACH MOTH.



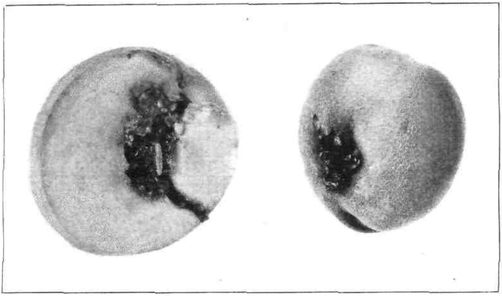
a. Ripe fruit with inconspicuous entrance marks of larvae near stems, late brood.



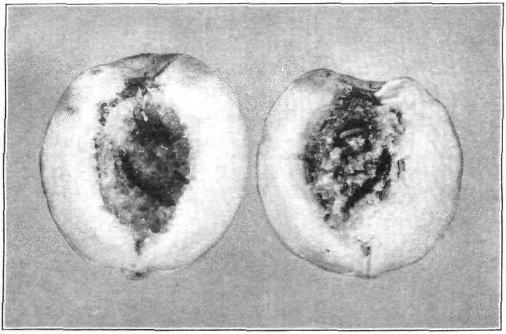
b. Exterior marks of infestation, early brood.

ORIENTAL PEACH MOTH.

PLATE XXVIII.

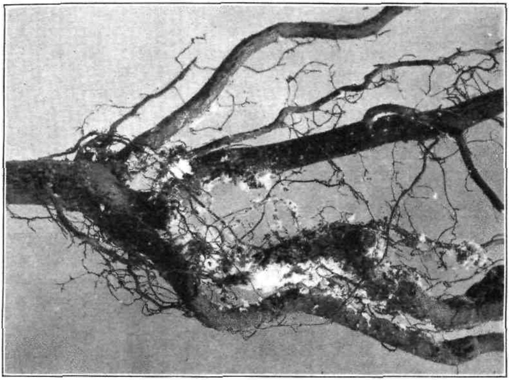


a. Peach with nearly full grown larva, left: exterior marks of infestation right.

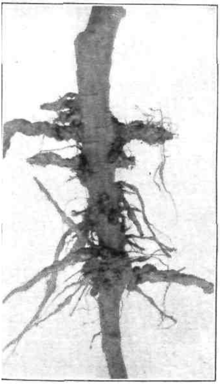


b. Ripe peach containing two larvae.

ORIENTAL PEACH MOTH.



a. Woolly apple aphid on roots of young trees.

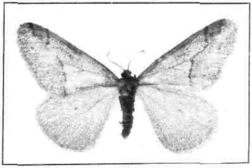


b. Nursery tree from the south. Feeding roots destroyed by decay following woolly aphid galls.

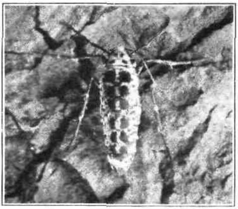
c. Woolly aphids on twigs, showing galls and white flocculent appearance.

WOOLLY APHID OF APPLE AND ELM.

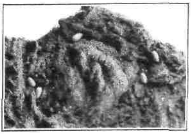
PLATE XXX.



a. Lime tree winter moth; male, natural size.

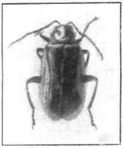


b. Lime tree winter moth; female, twice enlarged.

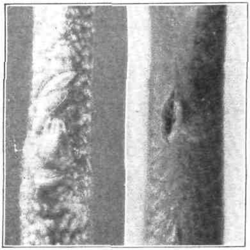


c. Lime tree winter moth; eggs, twice enlarged.

d. Lime tree winter moth; larva, natural size.

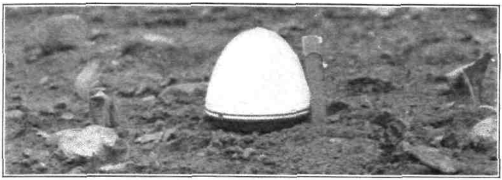


e. Western corn root worm, adult, four times enlarged.

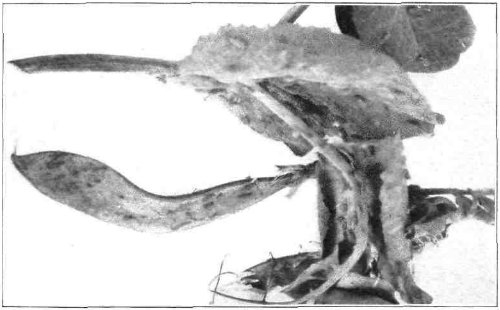


f. Blueberry spittle bug; left, twig with bark removed showing eggs; right, old egg-scar.

LIME TREE WINTER MOTH, WESTERN CORN ROOT WORM AND BLUEBERRY SPITTLE INSECT.



a. Trap used in experiments in attracting cabbage maggot flies.



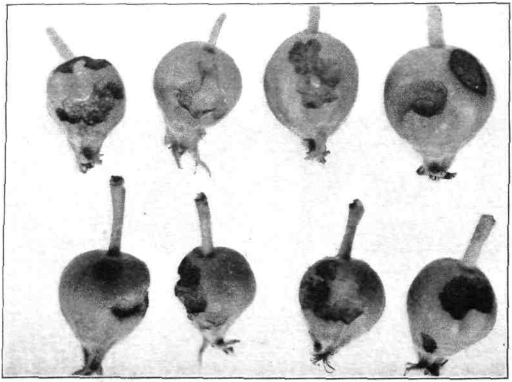
b. Section of pea vine infested with the pea aphid.

c. Applying nicotine dust to pea vines to kill aphids.

FLY TRAP AND PEA APHID.

PLATE XXXII.

a. Elm trees on Whitney Avenue, New Haven, nearly defoliated by canker worms, May, 1924.



b. Young apples from Station Orchard, Mount Carmel, eaten by canker worms.

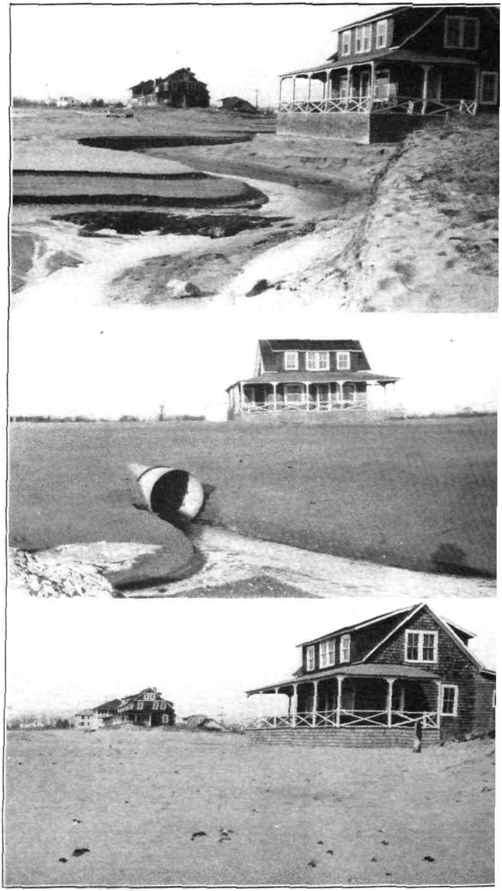
CANKER WORM INJURY.

a. Collecting *Anopheles* larvae in ornamental pool.

b. Laying 10 inch corrugated pipe Gourley Tract, Stamford.

c. Main drainage ditch at Southfield Point, Stamford.

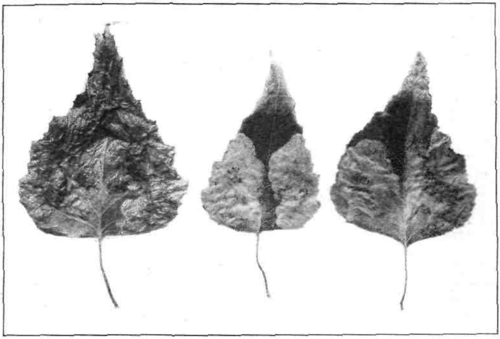
MOSQUITO WORK.



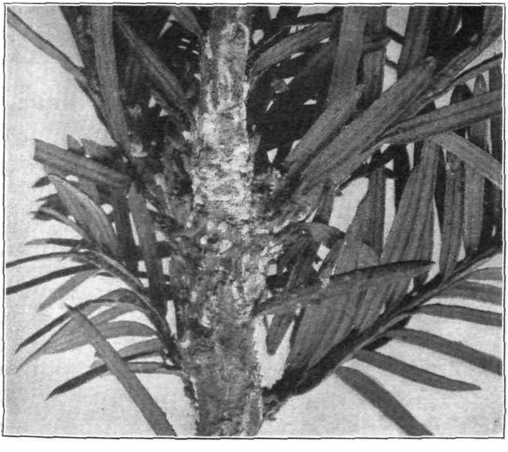
Above. Marsh outlet requiring continual labor to keep open.
Center. Two hundred and twenty feet of pipe installed gives perfe
drainage.
Below. Conditions one year later; natural sand fill removes danger
undermining cottage.

MOSQUITO WORK, MADISON.

PLATE XXXV.



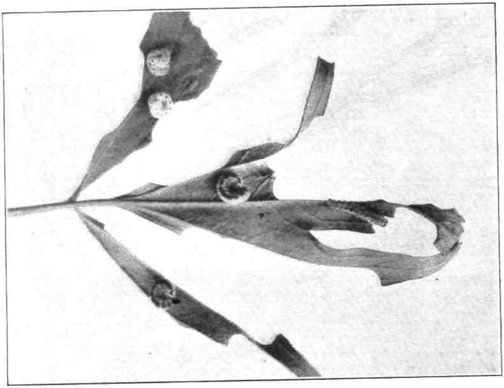
a. Leaves of the gray birch, *Betula populifolia*, mined by a European sawfly leaf-miner, *Fenusa pumila* Klug.



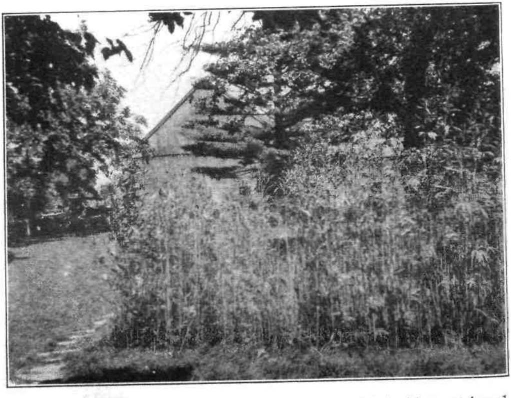
b. Taxus grown out of doors and infested by a mealy bug, *Pseudococcus* sp.

EUROPEAN SAWFLY LEAF-MINER AND MEALY BUG.

PLATE XXXVI.



a. Sawfly larvae feeding on Rudbeckia "golden glow", natural size.



b. Bed of Rudbeckia "golden glow", Westport, which had been stripped by sawfly larvae.

SAWFLY LARVAE ON RUDBECKIA "GOLDEN GLOW".

BULLETIN 266 MARCH, 1925

Connecticut Agricultural Experiment Station
New Haven, Connecticut

The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-Fertilized Lines

I. THE PRODUCTION OF INBRED STRAINS OF CORN

D. F. JONES
P. C. MANGELSDORF

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March 1925.

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The Wilson H. Lee Co.

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SUMMARY.

The results of previous investigations on inbreeding corn are reviewed to show the development of the method of selection in self-fertilized lines.

Four varieties of corn have been self-fertilized and selected for five generations. Eighty-six lines were started and twenty of these were lost or discarded.

The method of procedure was to grow three progenies in each line and self-pollinate five of the most desirable appearing plants in the best progeny each year.

A large number of clear-cut recessive abnormalities appeared during the course of the inbreeding. In all except one case these were eliminated by the fifth generation.

No significant difference in yield was found between segregating and non-segregating progenies in lines showing recessive abnormalities in the previous generation. Also lines having recessive abnormalities at the start showed no greater reduction in yield during the five generations than lines that were free from them throughout the experiment.

All lines showed a marked reduction in yield and a slowing down of the rate of growth. Although great differences were shown, no lines were as productive as the original variety. No appreciable correlation was found between the characters of the seed ear, weight of seed, size of seedling, or the appearance of the plants at pollinating time and the production of grain in the same generation.

Some correlation in certain characters was found between the first and last generations, particularly in height of plant and in per cent. of moldy ears. Less association was shown in amount of tillering and in smut infection, while in productiveness practically no relation was found, showing that good and poor yielding strains may come from productive or unproductive plants at the start.

THE IMPROVEMENT OF NATURALLY CROSS-POLLINATED PLANTS BY SELECTION IN SELF-FERTILIZED LINES.

I. The Production of Inbred Strains of Corn.

D. F. JONES and P. C. MANGELSDORF

The improvement of naturally self-fertilized plants, particularly the small grains, has gone steadily forward following the development of effective methods of procedure. In contrast to the older methods of mass selection based upon appearances, stands the system of individual plant selections chosen on the basis of the performance of their progeny, as worked out by Louis de Vilmorin in 1856 and later applied by Hjalmer Nilsson in 1891 at Svalöf in Sweden and by W. H. Hays at the Minnesota Agricultural Experiment Station in 1892. Although the early methods of applying the progeny performance test involved much unnecessary effort, the principle was sound and its extensive application has resulted in a large number of valuable new varieties of important crop plants, notably wheat and cotton. The theoretical soundness of this procedure, first applied in an empirical way, was later fully established by the re-discovery and demonstration of Mendel's Law, which postulates that a large part of inherited variability is due to the recombination of stable units. This led directly to Johannsen's genotype conception of organisms which appear alike but breed differently and those which are themselves diverse but give similar offspring.

The improvement of naturally cross-fertilized plants, reproduced by seeds, is in no such satisfactory situation. The variation brought about by Mendelian recombination makes it very difficult to have any adequate control over the heredity when interpollination is continually going on. Moreover, intensive selection for particular characters often results in decreasing the number of hybrid combinations and this, like all other forms of inbreeding, brings about a reduction in vigor. Any advantage which might come about from the concentration of desirable germplasm is offset by the loss of growth due to consanguinity.

Corn, a monoecious plant and wind pollinated, is almost completely cross-fertilized in every generation. This mode of pollination has brought about a condition in which a continuation of the same degree of germinal heterogeniety is necessary to maintain full vigor. The experimental results of inbreeding and crossing and their theoretical interpretation show clearly why the methods aimed at the improvement of corn in the past have been largely fruitless. Formerly the selection practiced with this plant was largely based upon the appearance of the mature ear. Investigation has shown that corn has now been brought to such a high plane of development that the correlation between the appearance

of the seed and the productiveness of the crop grown from that seed is very low; so low in fact that it is often possible to get as good results from planting the poorest looking ears to be found in a field as from the choicest specimens. This is due to the fact that hybrid combinations of hereditary factors which make possible high production can not be transmitted intact and therefore the offspring of any exceptional individual can not all be equally productive.

An early appreciation of this situation following the application of experimental methods to the study of corn breeding led to the ear-to-row system in which selection was based on the performance

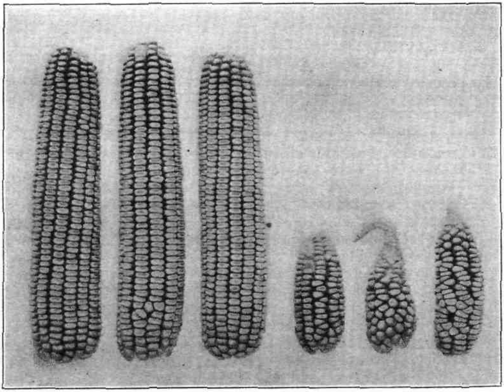

Figure 16. The seed from these large and small ears yielded the same. Their difference in size is due, not to heredity, but to the place where the plants that produced them happened to grow, one lot in a good, the other in a poor situation. This shows the complete lack of correlation in this case between the appearance of the seed ears and their performance.

of the progeny instead of the appearance of the seed parents. Although the progenies differed markedly in yield those above the average failed to maintain their high production in later generations.

In 1908 G. H. Shull outlined a method of corn breeding radically different from any previously followed. In this he called attention to the large number of germinally different types which exist in every field of corn and suggested that these could be separated out

by inbreeding. Although vigor was lost by this process this was to be regained by crossing inbred strains and utilizing only the first following generation in which hybrid vigor is at its maximum. East also advocated the same method and reached the same conclusions as to the importance of hybrid vigor, as the result of independent observations on the effects of inbreeding and hybridization. The crossing of different varieties of corn had been advocated long before this by Beal at the Michigan Agricultural Experiment Station, and Morrow, Gardner and McCluer at Illinois. Two important contributions to methods for corn improvement were made by Shull and East. One was making clear the complex germinal constitution of a variety in a cross-fertilized plant such as corn and the way in which the composition of any particular individual is masked by hybrid vigor. The other was in showing that the maximum degree of hybrid vigor could be secured by first reducing the plants to homozygosity and then crossing, thereby bringing about the greatest number of hybrid combinations of hereditary units. Both East and Shull considered hybrid vigor as a physiological stimulus resulting from the condition of hybridity itself, differing from the specific action of individual hereditary factors. For this reason they stressed the importance of securing the maximum effect of hybrid vigor. The more important service of inbreeding in automatically eliminating abnormalities and serious weaknesses and in making possible the detection and isolation of the potentially most valuable germplasm was not fully appreciated at first by those who attempted to apply this method to corn improvement. For that reason the full utilization of the pure line principle was delayed until hybrid vigor was shown to be merely the expression of dominant hereditary factors. This brought out clearly and forcefully the great value of inbreeding as a means of obtaining the finest hereditary material existing in a cross-fertilized plant like corn by controlling the inheritance through the pollen parent as well as through the seed parent, and fixing this in such a way that it would not be lost. Following up this line of attack a method of corn improvement was outlined in 1920 under the general title of "Selection in Self-fertilized Lines.".* It is here proposed to review the results of inbreeding and crossing which have led to the development of this method and show how inbreeding can best be applied to the improvement of corn and other naturally cross-fertilized plants. As the application of this method is still in progress the plan is to publish the results in a series under the general heading of "The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-fertilized Lines." The first of this series, submitted in the following pages, deals only with the detection and isolation of desirable hereditary qualities in corn, that is, the production of inbred strains which possess either in visible expression or in

*Jour. Agronomy, 12:77-100.

potential power those valued characters that make for increased production. Later publications are planned to deal with the testing and utilization of inbred strains of corn and the application of the same principle and method to other cross-fertilized plants.

Figure 17. Two inbred strains from the same variety that have been grown side by side for eighteen years. The difference in ability to stand erect is inherited.

The Effect of Inbreeding Upon Corn.

All of the main types of corn such as dent, flint, sweet, pop and lour corn have been inbred by self-fertilization for several succesive generations. The results have been the same in general for .ll types. Particular attention has been given to several strains esulting from a variety of Learning grown originally in central llinois. Inbreeding was started by Dr. E. M. East in 1905. Four ines descending from three individual plants at the start have been ontinued to the present time under the direction of Dr. H. K. Iayes and later by the writers, and in 1923 they had been inbred y seventeen successive self-fertilizations. The results obtained ave been reported from time to time. Particular reference is nade to "Inbreeding in Corn" and the "Distinction between)evelopment and Heredity in Inbreeding" by East, published in he report of the Connecticut Agricultural Station and in the American Naturalist, and "Heterozygosis in Evolution and in Plant Breeding" by East and Hayes in a Bureau of Plant Industry Bulletin. Later results are given in a bulletin of the Connecticut Agricultural Station under the title of "The Effects of Inbreeding .nd Crossbreeding on Development" and the "Attainment of Homozygosity in Inbred Strains of Maize" in Genetics by the enior writer. As the method of selection in self-fertilized lines

Table I.

Yield and Height of Four Inbred Leaming Strains of Corn Self-Fertilized ieventeen Generations.

	Strain A		Strain B		Strain C		Strain D	
No. of Gen. Selfed	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches
0	74.7	117.3	74.7	117.3	74.7	117.3	74.7	117.3
1	42.3	....	60.9	....	60.9	....	59.1	....
2	51.7	....	59.3	....	59.3	....	95.2	....
3	35.4	....	46.0	....	59.7	....	57.9	....
4	47.7	....	63.2	....	68.1	....	80.0	....
5	26.0	76.5	25.4	81.1	41.3	90.5	27.7	86.7
6	38.9	....	....	....	....	....	....	....
7	45.4	85.0	39.4	....	....	....	41.8	....
8	21.6	....	47.2	83.5	58.5	88.0	78.8	96.0
9	30.6	78.7	24.8	....	....	....	25.5	....
10	31.8	82.4	32.7	84.9	19.2	86.9	32.8	97.7
11	35.1	79.7	42.3	78.6	37.6	83.8	46.2	103.7
12	24.5	77.0	27.2	80.3	20.4	85.2	49.6	100.4
13	26.9	85.5	29.0	83.7	25.1	80.6	25.8	85.3
14	23.6	87.3	38.3	86.9	36.3	87.8	35.2	94.0
15	21.1	85.4	33.4	89.9	30.0	98.2	33.6	99.6
16	17.6	76.1	24.6	89.1	25.3	94.6	29.8	97.7
17	....	....	27.8	91.7	16.9	88.9	19.8	88.4

has been the direct outgrowth of these investigations as to the effects of inbreeding, a brief resumé of the results obtained to date will be given here.

The method of inbreeding followed in the earlier experiments was to self-pollinate a number of plants at random and use one of these as the progenitor for the following generation. Such a family descending from a single self-fertilized plant in each generation is called a line or strain. The yield of grain and height of plant of four lines from Learning during seventeen successive self-fertilized generations compared to the non-inbred variety are given in Table I. The four lines *A*, *B*, *C*, *D*, were derived at the start from three different plants. One of these was separated in the third generation into two lines, *B* and *C*. These have been continued separately since. Other lines were started from the same variety but have since been lost on account of failure to secure self-pollinated seed. In some cases this loss has been accidental, but for the most part these strains were maintained previous to their extinction with great difficulty and showed a much greater reduction in growth and vigor than the other strains which survived.

Although there is wide variation in yield of grain and height of plant from year to year the general direction is downward. After the ninth generation size and productiveness have remained on about the same level. The original variety yielded at the rate of eighty-eight bushels per acre the year it was first self-fertilized. In 1916 seed of the same variety was obtained from the original source and grown in comparison with these strains, then in the ninth or tenth generation. On account of its change to a new location under conditions to which it was not as well adapted as the inbred strains, which had been grown there for many years, no strict comparison can be made. In spite of their possible advantage the inbred strains were only from one-half to one-third as productive and were also noticeably reduced in height.

This decrease in yield which results from a reduction in size of all parts of the plant and a lessening of the growth rate has so far been the universal result of inbreeding corn as far as known to the writers. Several hundred self-fertilized strains have been grown long enough to bring this out clearly. Accompanying the lessening of productiveness and growth vigor there has been a reduction in variability. From a variety that showed the usual variation in height, color of silks, glumes and leaf sheaths, number of ears, position of the ear and other details in all parts of the plants there resulted in the four self-fertilized lines a marked uniformity among all of the plants within each line. This similarity in type became noticeable in the earlier generations of inbreeding, and after seven or eight successive self-fertilizations every plant in any one line was as much like every other plant in that line as any two plants in a naturally self-fertilized species, such as wheat or tobacco, from seed from the same individual. In other words, the vari-

ability that resulted from the recombination of hereditary factors was in time eliminated.

Figure 18. Two inbred strains from the same variety of flint corn, one with many tillers and the other without any.

Where the original variety had some plants with colored silks and others with uncolored, some of the lines now have all their plants with red silks while in others all the silks are green. In some lines the foliage on all the plants is a bright glossy green, in others a dull bluish green. All the plants of one of the lines remain green and stand firmly erect throughout the season while in other lines the foliage turns yellow towards the end of the growing season and in still another the plants frequently go down on account of a weak root system. Differences in susceptibility to smut are shown in these four strains as brought out in table II. In every detail of structure of the plant, including tassel and ears, all the individuals of one line are remarkably alike and noticeably different from the other lines. Some of these differences are shown in the accompanying illustrations, figures 17, 18 and 19. The uniformity within the line and the differences between the several lines are brought out statistically in tables III to VI, which show the height of plant, length of ear, number of nodes and rows of grain on the ear for the original variety and the four strains derived from this variety.

TABLE II.

Per cent. of Plants Showing Smut Infestation in Four Inbred Leaming Strains.

Strain	1917	1918	1919	1920	1921	1922	1923	Ave
A	.3	.7	1.9	14.3	15.2	3.0	.0	5.1
B	9.8	25.9	8.6	32.8	50.0	27.3	69.0	31.9
C	.5	9.1	4.1	6.0	13.8	17.5	52.7	14.8
D	.0	1.0	1.4	25.0	4.1	2.2	.7	4.9

During the early generations of self-fertilization various forms of abnormalities appeared. The most frequent of these are seedlings wholly or partially lacking in chlorophyll, various types of striped plants, golden plants, dwarfs, plants with ears showing many poorly developed and aborted seeds, and others with sterile tassels and ears. These are a few of the more strikingly aberrant types. Some of these are able to produce seed and when self-fertilized come true to their abnormal condition. Others are wholly incapable of reproduction and are eliminated, but the inbred strains in which they appear may continue to produce them regularly as part of their offspring in the following generations. After several generations these abnormalities are usually no longer produced and the remaining plants are all normal in type although reduced in size and in rapidity of growth. Many of the abnormal forms which appear in large numbers in the inbred families are occasionally seen in fields of corn which have never been artificially self-fertilized. Obviously, inbreeding is not responsible for their creation. They are recessive in mode of inheritance; that is, when crossed with other plants the following generation is all normal but the abnormality reappears in the subsequent generations.

Figure 19. Differences in height of two inbred strains from the same variety self-fertilized four generations and selected for vigor and productiveness but not for height.

TABLE III.

Frequency Distribution of Height of Plant of Leaming Corn and Four Inbred Strains Derived from It.

	Height of Plant in Inches. 58.5	63.5	68.5	73.5	78.5	83.5	88.5	93.5	98.5	103.5	108.5	113.5	118.5	123.5	128.5	133.5	138.5	143.5	N	A	C. V.
Variety	..	..	..	..	..	..	..	5	7	17	33	37	32	33	31	13	4	1	213	117.3±.48	8.81±.29
Strain A	2	2	2	24	48	37	4	..	..	..	..	..	..	..	..	..	..	..	119	78.6±.33	6.78±.30
Strain B	3	6	10	11	24	42	59	39	7	..	..	..	..	..	..	..	..	..	201	84.6±.41	10.22±.35
Strain C	..	1	2	9	11	26	21	21	12	2	..	..	..	..	..	..	..	..	105	86.7±.54	9.46±.44
Strain D	..	..	..	..	2	2	18	56	79	50	8	4	..	..	..	..	..	..	219	97.9±.26	5.91±.19

TABLE IV.

Frequency Distribution of Length of Ear of Leaming Corn and Four Inbred Strains Derived from It.

	Length of Ear in Inches. 2	3	4	5	6	7	8	9	10	11	12	N	A	C. V.
Variety	..	..	5	15	32	65	61	37	10	2	1	228	7.5±.06	19.07± .63
Strain A	..	4	17	69	24	..	..	..	..	..	..	114	5.0±.04	14.18± .65
Strain B	8	31	88	82	2	..	..	..	..	..	..	211	4.2±.04	19.94± .68
Strain C	1	4	16	26	32	6	..	..	..	..	..	85	5.2±.08	20.17±1.08
Strain D	..	3	17	31	58	81	27	2	..	..	..	219	6.3±.05	19.00± .63

TABLE V.

Frequency Distribution of the Number of Nodes of Leaming Corn and Four Inbred Strains Derived from It.

	Number of Nodes. 8	9	10	11	12	13	14	15	16	17	18	N	A	C. V.
Variety	..	..	2	5	23	49	79	60	11	12	4	245	14.1 ± .06	10.07 ± .31
Strain A	..	..	..	5	21	66	26	1	..	..	..	119	13.0 ± .05	5.97 ± .26
Strain B	1	2	11	33	103	51	8	1	..	..	..	210	12.0 ± .05	8.21 ± .27
Strain C	..	1	2	15	30	44	16	..	..	..	..	108	12.5 ± .07	8.18 ± .38
Strain D	..	1	1	48	113	59	9	..	..	..	..	231	12.1 ± .04	6.77 ± .21

TABLE VI.

Frequency Distribution of the Number of Rows of Grain on the Ear of Leaming Corn and Four Inbred Strains Derived from It.

	Number of Rows of Grain on the Ear. 12	14	16	18	20	22	24	26	N	A	C. V.
Variety	3	14	51	75	52	21	7	4	227	18.4 ± .12	14.22 ± .46
Strain A	39	70	3	2	..	..	..	..	114	13.4 ± .08	8.94 ± .40
Strain B	..	..	1	22	56	78	43	6	206	21.5 ± .09	9.38 ± .31
Strain C	..	24	42	18	1	..	..	..	85	15.9 ± .11	9.26 ± .48
Strain D	11	90	86	26	2	..	..	..	215	15.2 ± .07	10.50 ± .34

In ordinary fields of corn they are generally kept out of sight by continual crossing with normal types which are dominant. Plants carrying such factors for abnormality, when self-fertilized, produce them in approximately one-fourth of their progeny. Some of the normal plants in the same progeny carry the abnormality and some do not. Sooner or later, progenitors are used which do not carry any of these striking abnormalities, after which they cease to appear.

The rate at which reduction in growth takes place and the final size and productiveness of the several lines, after the reduction comes to an end, vary in different lines. Of the four Leaming strains the *D* line has regularly been taller and larger and has yielded more than the others. The rate of reduction has been nearly alike in all of the four lines although *A* was reduced in yield somewhat more quickly than any of the others. The attainment

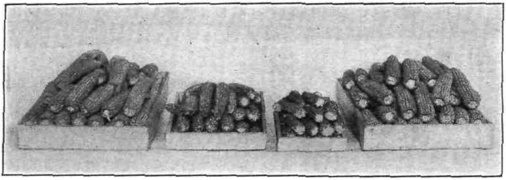

Figure 20. Comparative production of a variety of Leaming corn, two inbred strains derived from this variety, and their first generation hybrid. Grown in adjoining rows, they yielded 96, 32, 20 and 115 bushels per acre respectively.

of uniformity may also proceed at a different rate, depending upon the degree of heterozygosity of the plant chosen as progenitor. Some strains remain variable for many generations while others become uniform in nearly every feature after a few generations of self-fertilization.

From the foregoing facts it is obvious that inbreeding is a process of sorting out. From a mixture of many genetically different individuals all varying in hereditary composition and in heterozygosity any number of homozygous lines can be ultimately obtained, each differing to a greater or less degree from every other. A naturally cross-fertilized species is thus changed into an artifically self-fertilized species. In uniformity and constancy these artificially inbred plants are quite comparable to naturally self-fertilized species, with the important difference that in corn they are markedly reduced in size and vigor.

RESULT OF CROSSING.

The vigor which is lost by inbreeding is at once restored when two self-fertilized lines descending from different plants at the start

Figure 21. Two inbred strains and their first generation hybrid showing differences in time of flowering.

are crossed. This is shown in figure 20. Here the ears produced by the original non-inbred variety are shown in comparison with the ears produced by two lines self-fertilized 12 generations and the

first generation hybrid between these two lines. An equal number of plants of the four lots were grown in adjoining rows and yielded 96, 32, 20 and 115 bushels per acre respectively. A comparison of a large number of first generation crosses between inbred strains derived from the same variety showed that the yield of the hybrids was increased 180 per cent., height of plant 27, length of ear 29, number of nodes 6, and rows of grain on the ear 5 per cent. above the average of their inbred parents.* From this it is seen that size characters such as height of plant and length of ear are affected more noticeably by hybrid vigor than the number of parts, such as nodes and rows of grain on the ear, while yield, which sums up

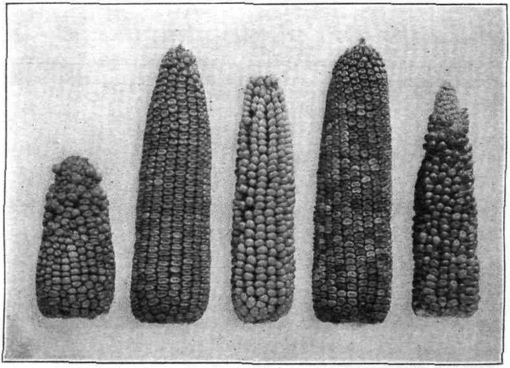

Figure 22. Representative ears of three inbred strains of dent corn and two first generation hybrids resulting from the crossing of the two adjoining types, harvested at the same time to show the difference in maturity.

the entire growing capacity of the plant, is increased more than anything else. In other words hybrid vigor has much the same effect as favorable environmental factors. Fertile soil, good season and careful cultivation influence the growth of the corn plant. Under these conditions corn grows taller, the ears are larger and the production of grain is much greater than under the less favorable conditions, while the number of nodes or the rows of grain on the ear are not so much changed.

*"The effects of inbreeding and crossbreeding upon development." Connecticut Agric. Exper. Station Bull. 207.

Another noticeable effect of crossing inbred strains of corn is that of hastening the time of flowering and maturing. Figure 21 shows two inbred strains in which the tassels are just beginning to appear. No silks are out. The first generation hybrid of these two strains in the center is shedding pollen from nearly all of the tassels and the silks are well out on many of the plants. Representative ears of three inbred strains and first generation hybrid ears resulting from the cross of the two adjacent strains are pictured in figure 22. All were picked at the same time and show the greater maturity of the hybrid ears.

All of the combinations of inbred strains have shown increased

Figure 23. A first generation hybrid showing the uniformity in height and in tassel type. The two inbred parental strains are in the adjoining rows at the left.

growth and yield whether the parental strains come from the same original variety or from different varieties. Some combinations have yielded more than others. A few have been better than others in many respects. Crosses between strains from different varieties have not been conspicuously better than crosses within the variety although no extensive test of this point has been made. Furthermore, no reliable comparison of the yield of the hybrids with the original variety can be made because this variety is not well adapted to the local conditions in which the self-fertilized

lines have been grown for many years. Kiesselbach reports the average yield of seven first generation hybrids tested two years as 52 bushels per acre in comparison with 42 bushels for the original variety. This is an increase of 24 per cent. The highest yielding hybrid produced 59 bushels or an increase of 40 per cent.

The most noticeable and important feature of the first generation hybrids between fixed inbred strains is the even growth, similarity in size and structural details and uniform production of all plants where the growing conditions are equal. This is shown for height of plant and tassel type in figure 23. Barring accident every plant is like every other plant. They grow to the same height. All ears are borne usually at the same node. The tassels and silks appear at the same time and the plants all ripen within a few days of each other. The fact that every plant produces a good ear is a most important factor in making crosses between strains so productive. In ability to yield from every plant and in uniformity of ripening, these first generation corn hybrids are equal to any naturally self-fertilized crop such as wheat and tobacco or any vegetatively propagated plant as potatoes and sugar cane. Since corn is very susceptible to damage by unfavorable weather at pollinating time, the uniformity in flowering may be undesirable particularly in those regions where hot dry weather is a frequent occurrence at this critical time. For that reason some other method of utilizing inbred strains may prove to be more practicable. This will be considered more fully in later publications. It is sufficient here to point out that in these first generation hybrids we have a new kind of corn which in many important respects is radically different from the mixtures of hybrids of varying degrees of heterozygosity now constituting an ordinary field of corn.

An Interpretation of Hybrid Vigor.

The observations of gardeners and animal husbandmen have led to a general conviction that crossing somewhat different but related plants or animals usually results in a greater growth. Many instances of this phenomenon of hybrid vigor, in which the offspring excel both parents have been noted in the higher plants and in mammals, birds, insects and some of the lower forms of animals. Larger size or more rapid growth usually results when the parents are visibly different in some respects but are sufficiently related to produce fertile offspring. Many notable cases of hybrid vigor also occur in wider crosses where the offspring are partially or wholly sterile. This is well illustrated by the mule, which is sterile. A similar wide cross in plants is the combination of the radish and cabbage in which the hybrid makes a luxuriant growth but sets no seed. Some species crosses show no increased vigor but on the other hand may be extremely weak. East and Hayes have given several illustrations of tobacco hybrids which are barely able to live and make only a weak growth. Many crosses

of different species in animals and plants do not develop normally. Hybrid weakness as well as hybrid vigor must be taken into consideration although this is not be to expected in crosses that are fertile.

After the limits of physiological compatibility are reached cross-fertilization cannot be accomplished. A series can therefore be arranged as follows: (1) Crosses between organisms which are so nearly alike in germinal constitution that no increased growth

Figure 24. Crossed corn showing vigorous growth.

results. (2) Crosses between germinally diverse but closely related organisms that grow to a larger size and at a more rapid rate and are fully fertile. (3) Sterile crosses between more distantly related organisms which are extremely vigorous. (4) Sterile crosses which are weak and often abnormal. (5) Crosses which cannot be made on account of the germinal difference in the forms united.

Hybrid vigor in domestic animals and cultivated plants most frequently results when breeds or varieties of different type are brought together. Thus it is a common practice to cross the

bacon and lard types of hogs or the mutton and wool breeds of sheep to secure some of the advantages of both parental races. Dent and flint varieties of corn when crossed usually give greater increases in yield than crosses within either type. In these diverse crosses many of the desirable features of both parental races are brought together. How this works is well illustrated in the cross of a "golden" type of corn which is deficient in chlorophyll with a "dwarf" as shown in figure 26. The plants resulting from this cross are tall, normally green and quite vigorous and productive. In this particular case one parent contributes normal stature and the other normal chlorophyll. Both these characters are dominant over the recessive condition so that all the hybrid plants

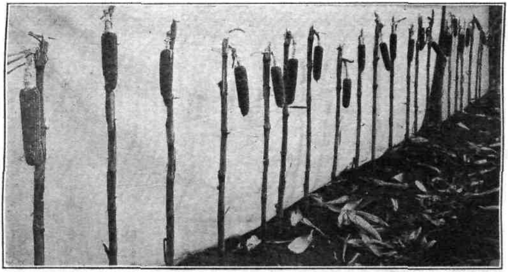

Figure 25. It is the uniform production of a good ear on every plan- that makes the first generation hybrids between inbred strains so product tive.

are alike in their tall stature and green color. Another case is shown in figure 27 of two dwarfs which are genetically different and which, when crossed, give a tall, vigorous hybrid. One of the dwarfs lacks something essential to normal height and all the plants are alike as long as they are not out-crossed. The other dwarf is lacking in some other essential factor present in normal corn. When these two small plants are combined each type supplies what the other lacks so that the result is normal stature in all the hybrid plants the first year after crossing. These illustrations of the result of crossing are extreme cases which show how conspicuous abnormalities are suppressed by crossing so that the hybrid offspring are able to make a greater growth than either parent. The same situation in principle exists in all crosses from

which hybrid vigor ensues. Different organisms possess different hereditary qualities. When brought together there is always a tendency for the hereditary factors which make for greater growth vigor to dominate the factors for lesser growth. The bringing

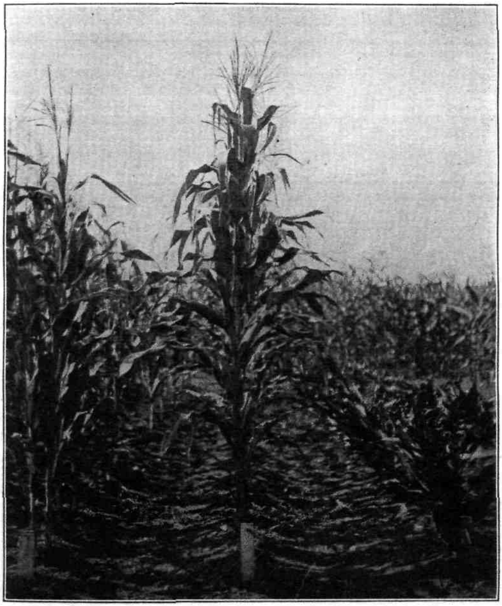

Figure 26. The result of crossing a golden, liguleless type, on the left, with a green dwarf on the right. The hybrid, in the center, has tall stature, normal foliage and green chlorophyll due to dominant factors contributed by each parent.

together of the best of both parents in this way gives the hybrid offspring a temporary advantage over either parent in the first generation following the cross. Recessive weaknesses are con-

tinually occurring as mutations as shown by the many controlled observations on the fruit fly and other forms of life. In cross-fertilized organisms, and particularly in domesticated animals and plants, crossing keeps these covered over and out of sight by combining them with normal factors. Many of these recessive weaknesses are not distinct and visible characters as are the

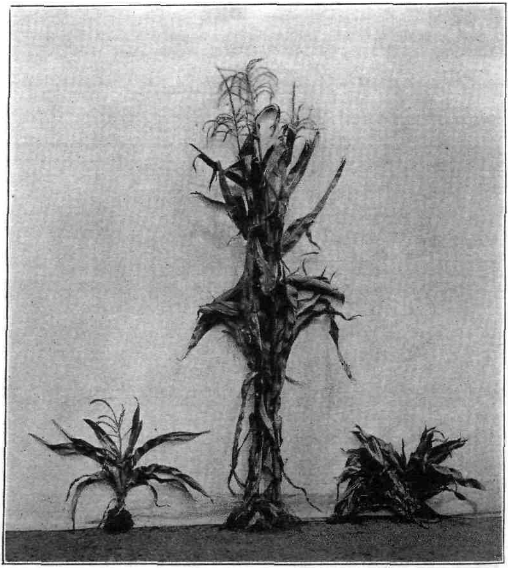

Figure 27. Two genetically different dwarf types give tall plants when crossed, due to the fact that the normal growth factor which each lacks is supplied by the other.

chlorophyll deficiency or dwarfness in corn but nevertheless they weaken the organism in some way. When such crossbred races are inbred, the heterozygous combinations are reduced and the resulting individuals which are homozygous to a greater and

greater degree, as the inbreeding is continued, show the recessive weaknesses and are either unable to reproduce themselves or are reduced in size and rate of growth to a point below that of the original stock. The inbred individuals each receive some of the hereditary factors for vigorous growth. Some receive more than others as a chance allotment and are therefore better able to survive the inbreeding process. Others are so weakened that they perish. On account of the way in which the hereditary mechanism operates it is extremely improbable that any one individual will receive all the more favorable growth factors, and in actual practice inbred strains of corn are all reduced by inbreeding. It is theoretically possible to obtain individuals which possess an unusually large share of the more favorable growth factors or even all of them and for that reason show no reduction from inbreeding. Darwin obtained self-fertilized races of *Ipomea* and *Mimulus* which were more vigorous than the naturally cross-fertilized variety at the start. Cummings reports self-fertilized strains of squash that are as productive as the original variety and much more uniform in type. King has obtained inbred rats after long-continued brother and sister mating that are fully as vigorous as the material with which she started. The fact that no such result has been obtained with corn shows how dependent this plant has become upon cross-fertilization to maintain production.

The Transitory Nature of Hybrid Vigor.

The increased growth resulting from crossing is quickly lost in the following generations when the hybrid individuals are bred among themselves or again inbred. In other words, hybrid vigor is a temporary manifestation which ordinarily cannot be fixed and made permanent in sexually reproduced offspring. The reason for this is readily appreciated when the illustrations previously given are followed into the later generations. The cross of the golden and dwarf corn gives all normal tall green plants in the first hybrid generation. Seed from these hybrid plants, either selfed or inter-crossed, always gives in the next generation all the possible combinations of characters that went into the cross. In this particular case the golden plants also lacked the ligule which is the small extension of the leaf sheath surrounding the stalk above the leaf blade. Liguleless plants hold their leaves in a characteristically upright position close to the stalk. In the second generation of this cross of liguleless golden by dwarf, eight different kinds of plants are produced. These are shown in figure 28. Due to the recombination of Mendelian units, this generation is extremely variable, and while some of the tall, green, liguled plants may be as vigorous and productive as the first crossed plants this generation as a whole averages much less productive. By further inbreeding, eight distinct pure-breeding combinations of these three characters

can be obtained and within each type still further minor differences could be established. Crossing any two of these types gives increased growth and restores the normal condition provided the factors for normal growth are all present in one or the other type.

In the same way the vigorous and productive crosses between inbred strains of corn fall off in size and yield in the second generation and are much more variable. This always results whether the first crossed plants are self-fertilized or are inter-crossed among themselves. If the inbred strains are uniform and fixed in their type the first generation hybrid plants are germinally all alike so

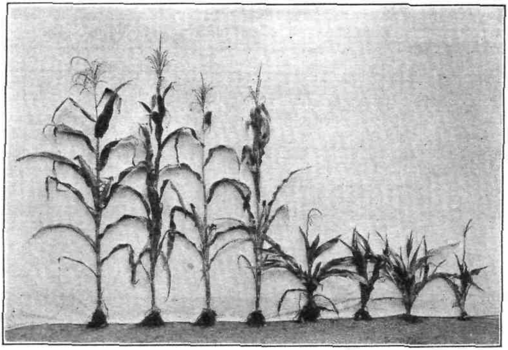

Figure 28. The second generation offspring from the crossing of golden liguleless by dwarf. Eight different combinations of these three characters are obtained by Mendelian segregation and recombination.

that it is easily understood why self-fertilization and inter-crossing give the same result. To test this out two inbred strains were crossed after 14 generations of self-fertilization. A number of the hybrid plants were self-fertilized and an equal number were inter-pollinated. The seed of these two lots was planted in alternate rows, replicated three times. The self-fertilized plants averaged $76.2 \pm .57$ inches in height in comparison with the intercrossed plants which averaged $73.8 \pm .70$. In production of grain they stood respectively 22.2 ± 1.2 and 22.0 ± 2.4 bushels per acre. In neither case are the differences significant.

INBREEDING AFTER CROSSING.

When the second generation plants are allowed to intercross naturally no further reduction in vigor is expected. Variability and yield should remain at the same level thereafter until natural or artificial selection eliminates certain strains. But when the second generation plants are self-fertilized there is a further reduction in size, and if the inbreeding is continued the decline in size and vigor and in variability proceeds in approximately the same way as when the parental strains were first inbred. This is shown in figures 29, 30 and 31.

In this demonstration of inbreeding after crossing, two inbred strains, self-fertilized for eight generations, were crossed and the first generation plants again self-fertilized. In the second generation a single plant was again chosen as the progenitor and pollinated in the same way, and this was continued for eight successive

Figure 29. The result of inbreeding after crossing. Two inbred strains at the left, their first generation hybrid adjoining, followed by seven successive generations self-fertilized.

generations. Seed was saved from each year's selfing up to the fifth generation. Since corn seed will not retain its germination satisfactorily for more than six years, single plants were again self-fertilized the fifth year in each generation and this seed was used from then on. All eight inbred generations were grown in 1923 along with the two parental strains as shown in the accompanying illustrations. This demonstration has been grown each year since the original cross was made and the yields obtained in the different years are given in table VII. Production has varied rather widely from season to season and from generation to generation. This is due in part to the character of the individual plants chosen for progenitors. A very noticeable drop takes place from the first to the second generation amounting to over 30 per cent. as an average of the six years. Kiesselbach tested the first and second generations of eight hybrid combinations of different strains during two seasons and obtained an average of 52.2 and 27.8 bushels per acre respectively for the two generations, to be com-

pared with 41.7 bushels for the original corn from which the inbred strains were obtained. He secured his seed for the second generation by pollinating several first generation plants with composite pollen from 15 sib plants. The reduction from the first to the second generation of nearly 50 per cent. is even greater than in our case where the plants were self-fertilized. Kiesselbach also grew a third generation from seed of interpollinated plants. The comparative yields obtained for the first, second and third generations were 51.5, 29.4, and 25.6 bushels per acre. The reduction from the second to the third as would be expected from this mode of pollination is small compared with the drop from the first to the second. Continued inter-pollination should cause no further decrease in yield unless particularly unfavorable strains are isolated.

The average height of these successive self-fertilized generations compared with the first generation hybrid and the parental strains is shown graphically in figure 32. There is a continued

TABLE VII.

The production of grain in bushels per acre, of two inbred strains of *corn and their hybrid and the F_1 to the F_8 generations successively self-fertilized.*

Year Grown	P_A	P_B	F_1	F_2	Generations F_3	F_4	F_5	F_6	F_7	F_8
1917	22	6	65	56	....	....	....	....	....	....
1918	27	24	121	128	15	....	....	....	....	....
1920	16	28	128	48	35	29	10	....	....	....
1921	20	13	73	55	49	33	15	23	....	....
1922	20	26	160	83	74	68	49	36	23	....
1923	13	21	61	45	41	47	16	23	26	27
Ave.	20	20	101	69	43	44	23	27	25	27

reduction in each generation, but the decrease is much less during the last three generations than in the first four. From the first to the fifth generation there is a decline of 27.2 inches in stature and from the fifth to the eighth 8.6 inches. The rate of growth as measured by the daily gain in height is also steadily reduced as shown in figure 33, the decline being greater during the first stage of inbreeding than in the last. The differences between the last two generations in all measurable characters, including yield, height, length of ear and rate of growth, are so small that it seems evident that the reduction in size and vigor is rapidly approaching an end. The last two generations are so similar in appearance that they cannot be distinguished in the field. In tassel type, foliage character, position of the ear on the stalk, and in the size and conformation of the ears these two generations are practically identical.

The reduction in variability from the first to the eighth generation was very noticeable in the field. One of the parent strains has green silks, the other red. The first generation hybrid plants

all had red silks. The second, third and fourth generations segregated for this color while the remaining generations were all uniformly colored. Height of plant, position of the ear on the stalk, form of tassel and all structural details were noticeably uniform in the parents and the first hybrid generation. The plants in the generations from the second to the fifth were quite variable but later became more and more uniform until in the last two generations they showed as little variation as either of the parental strains.

The inbred strain which resulted from this second period of self-fertilization differs from both parental strains. In tassel, ear, and character of the foliage it is quite unlike either but is noticeably susceptible to smut like one of the parents. In other words,

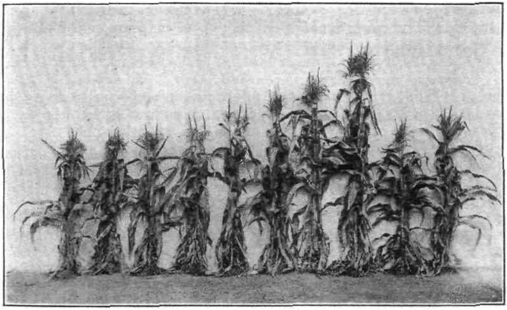

Figure 30. Inbreeding after crossing. Representative plants from the generations shown in figure 29.

Mendelian recombination has taken place so that the details of structure are altered. Apparently this inbred strain has about the same number of favorable growth factors, and for that reason it is no better or no worse than the parental stocks that went into the vigorous and productive hybrid from which the new strain was derived a few generations before.

For all practical purposes the reducing effect of self-fertilization in this particular case has ceased at the sixth inbred generation. This closely parallels the course of events when the parental strains were first inbred. Theoretically the loss of vigor follows the rule of halving the remaining difference in each generation. If we take an individual heterozygous for a single Mendelian pair of factors such as *Aa* we expect in the next generation fifty per

cent. of the plants homozygous for this pair of factors and having the composition *AA* or *aa*; the other fifty per cent. will on the average still be heterozygous for this factor pair; i. e. *Aa* in composition. In choosing a single self-fertilized individual for the progenitor the chances are even that it will be homozygous or heterozygous. This holds for any number of factor pairs and since each pair when once alike must remain so thereafter in self-fertilization the number of mixed pairs is steadily reduced by half in each generation. Starting with an individual 100 per cent. heterozygous, the following generations would be on the average 50, 25, 12.5, 6.25, 3.125, 1.5625, etc.

Naturally the progeny of any heterozygous individual will vary greatly in composition. Some will be nearly or completely homozygous while others will be nearly or completely heterozygous with respect to all factor pairs. For that reason the result of any process of inbreeding depends entirely upon the composition of the individual plants which are chosen as progenitors. It is theoretically possible to obtain individuals in each generation which are as heterozygous as their parents and others that are completely homozygous. For that reason inbreeding may cause no reduction in size, vigor or variability, or complete reduction may take place in a single generation. The chances that such a result will be obtained, however, are extremely remote. Actually the reduction follows the rule of halving the remaining difference very closely so that it is evident that a very large number of factors play a part in hybrid vigor. How many such factors there are, we have no way of estimating at the present. Many factors which bring about visible differences possibly have no effect upon vigor but apparently the number of them which are essential to normal development in corn is exceedingly great.

The Attainment of Complete Homozygosity.

Whether complete fixity of type, absolute homozygosity, is possible of attainment by continuous self-fertilization has been previously discussed. (Jones 1924.) The experimental results show that small germinal differences may remain after many generations of inbreeding. Two lines separated from one in the third generation and then continued separately for several generations gave a marked increase in size when crossed, although not as great as in the case of lines separated at the beginning, showing that two self-fertilizations had not produced much uniformity in germinal constitution. The four original Leaming strains were continued as single lines up to the eighth generation. At that time they were all remarkably uniform and apparently fixed in their type. Then each line was separated into two lines which were continued separately thereafter for eight or more additional generations. At that time two of the paired lines had remained exactly alike. No visible differences in any respect could be seen.

One of the paired lines differed only in color of the seeds, one being noticeably brighter in color in some seasons. As the growing conditions were alike for all plants this slight difference can not be accounted for in any other way than as an heritable difference. The other paired line differed noticeably in many respects. One of the members was taller, the leaves were broader and lighter colored and the ears were larger, the seeds broader and duller in color.

Crossing these paired lines gave significant increases in all measurable characters in the one strain whose paired lines were visibly different. The other strains all showed slight but apparently significant increases in some characters. The two strains whose paired lines showed no visible differences were again tested after fourteen generations of self-fertilization in the following way. The two strains which were distinct from the beginning were crossed and gave the usual vigorous and uniform hybrid plants. A

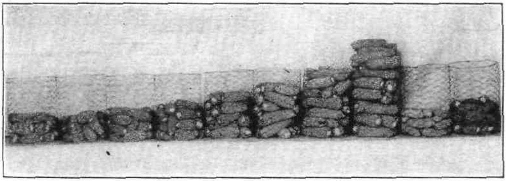

Figure 31. Inbreeding after crossing. The production of grain from the plants shown in figure 29.

number of these were self-fertilized and an equal number were inter-pollinated by sib plants. A careful test failed to show any differences in size or productiveness in the plants grown from these two lots of seed. If the parental strains were not germinally alike within themselves, intercrossing the first generation hybrid plants would not cause such a decrease in heterozygosity as self-fertilization. The fact that no difference was shown indicates that the parental strains were completely homozygous for all factors which influence growth vigor. However, this test is not a very delicate one and final proof awaits the crossing of the paired lines which have been separated in the seventeenth generation and will be carried along for several additional generations.

Mutations in Corn.

Complete homozygosity may be impossible to attain because of spontaneous variations, mutations, occurring from time to time.

During the seventeen years in which the four inbred Leaming strains have been under observation only two apparent germinal changes have been recorded. Until a fairly high degree of uniformity was reached, after six generations, various abnormalities occurred singly or in greater numbers in the rather small progenies that were grown. Presumably these were, at least in the great majority of cases, merely segregations from a heterozygous complex. But new characters appearing after uniformity is obtained which have not been noted previously have every indication of being mutations. Two such have been observed in different lines. One produced in the thirteenth generation a single self-pollinated ear segregating for defective seeds. All of the lines had been examined for the new character during three previous generations, without noting anything of this kind, and since the character

Figure 32. Graph showing the height of the two parental strains and the generations from the F_1 to F_8.

segregated as a single Mendelian recessive when out-crossed, there is every reason to assume that a germinal change took place shortly before its appearance. Among approximately a thousand plants of another line, self-fertilized more than ten generations, which has always produced white cobs, four ears were found with light red cobs. The cobs of this strain are flattened and the plants are otherwise easily identified. The red cob plants were examined at harvest and noted to be typical for the strain in all respects except cob color. Neither of these changes could have been due to out-crossing. Stray pollen from any outside source immediately results in vigorous plants twice as large as the inbred plants ever grow and the crossed plants are completely changed in type. Since the mutant plants were in other respects typical plants of the strain and were no larger they could not have resulted from out-crossing.

Two additional changes have occurred in other inbred material

such that they have every indication of being recent germinal alterations. One strain after five generations produced for the first time striped, variegated plants which bore no pollen or seed. They occured in later generations in about 25 per cent. of the offspring from normal plants. Another strain after nine generations gave small narrow-leaved dwarf plants which were quite distinct from the normal plants. They produced a small amount of pollen and when out-crossed to normal plants they reappeared in later generations showing that the change was heritable.

These four apparent mutations are all that have been noted in a large number of uniform strains which have been under observation for many years. Hayes and Brewbaker record the production of chlorophyll deficient seedlings in four lines out of 953 which had

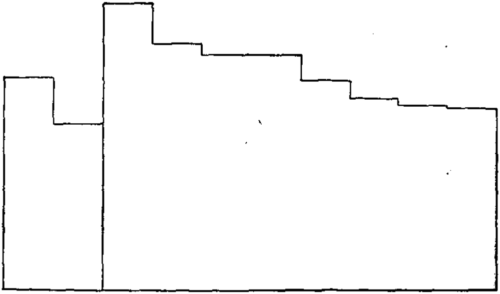

Figure 33. Graphs showing rate of growth (average daily gain in height) for the same generations as in the preceding illustrations.

not shown such abnormalities previously. In these cases the appearance of the abnormalities may have been due to delayed segregation, since the lines had not been reduced to uniformity and constancy. While it is evident that corn does mutate, the frequency of these changes is so low that inbred strains, when once reduced to uniformity, are stable for all practical purposes. Some care will be needed to maintain self-fertilized lines true to type, and when recessive abnormalities appear those progenies which show them will have to be discarded.

The Value of Inbreeding.

This review of the effects of inbreeding and crossing upon corn has been given in considerable detail because the facts learned from

these investigations form the basis for the method of improvement by selection in self-fertilized lines. In the inbreeding experiments just described *no selection of superior individuals to perpetuate the* strain was made. The aim was to take normal plants at random and note the outcome. Nevertheless a great deal of natural selection has taken place. All abnormalities which interfere with or markedly reduce reproductive ability have been automatically eliminated. In this way many chlorophyll deficiencies, endosperm abnormalities and inherited sterility in tassels and ears, unfavorable conditions almost always present in every cross-pollinated

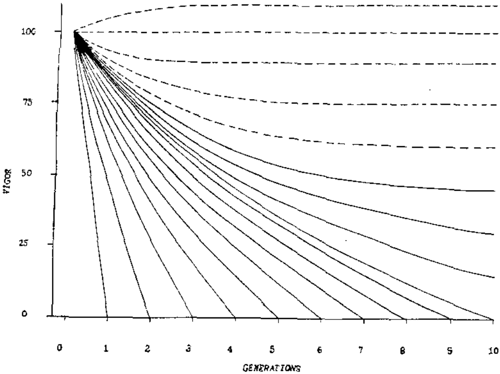

Figure 34. A diagrammatic representation of the actual and theoretical results of inbreeding corn. The solid lines represent strains which have already been obtained, the dotted lines those which may be expected when corn is worked with more extensively.

variety of corn, have been cleaned out. But this outcome of inbreeding, valuable as it may be, is less important than the control over the heredity made possible by hand pollination and the resulting fixity of type.

In common practice, selection with nearly all cross-fertilized plants has been based on the appearances of the plant or upon the performance of the progeny, and no adequate control of the heredity brought in from the pollen parent has been possible. As generally practised, corn breeding has been similar to a system of animal breeding in which selection is carried on only with the dams paying no attention whatever to the sires. The disastrous

result that such a system would have upon purebred live-stock can readily be appreciated. With all cross-fertilized plants it would be theoretically possible to follow the method now used in animal breeding. Certain desirable individuals could be chosen as seed parents and others as pollen parents. Pollination could be made by hand and the progenies compared on the basis of their performance. There is no doubt that this system followed up as carefully as it is in mating farm animals would give equal results. But such a method is wholly impracticable on account of the small value of the individual plant. The time spent on selecting the

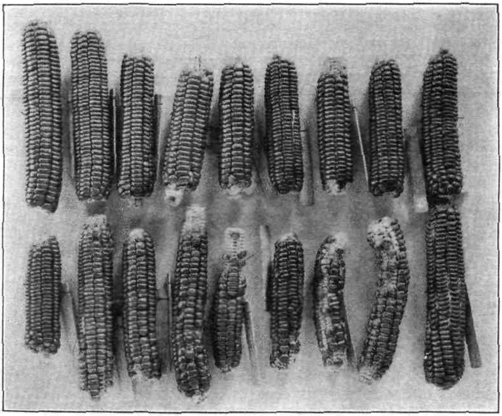

Figure 35. Self-pollinated ears grown on selected plants of Burwell's Yellow Flint, No. 40. Each ear is the starting point of a selected line. These are numbered 1 to 9, top row, and 10 to 18, bottom row, left to right.

parents and on pollinating each generation would not be repaid by the possible gains. Furthermore, with corn, selection is greatly handicapped due to the fact that the principal objective, production of grain, is not visible until after pollination.

A new method of attack, which will make possible a control of the heredity transmitted thru the pollen as well as thru the egg, is needed for all naturally cross-fertilized plants. Since inbreeding is a sorting-out process, selection carried on during the time the plants are being reduced to uniformity and constancy makes

it possible to look for desirable qualities with a certainty of being able to hold them, when once secured, that has never before been possible. From this viewpoint inbreeding is not so important as a method of gaining the maximum effect of hybrid vigor when the inbred strains are crossed as it is of separating out and making visible the very best hereditary qualities that may exist in a heterozygous stock. Strains when once reduced to fixity remain the same indefinitely, barring mutations. With due regard to seasonal variation, crosses between inbred strains give the same result whenever the same combination is made. The uniform production of the first generation hybrids between homozygous strains is an important feature. In this respect cross-fertilized plants are equal to self-fertilized plants in uniformity and fixity of type and have the added advantage of crossing to bring together and use in the first generation the desirable qualities within the species, which in a self-fertilized organism can be used only when recombined and fixed in a homozygous condition. It should therefore be clearly understood that the crossing of inbred strains as such is without particular value and that the opportunity afforded to find and to fix the very best hereditary qualities possessed by a cross-bred race is the more important function of inbreeding. Crossing is merely a means of utilizing this good heredity by giving it maximum vigor. It is to be expected that many inbred strains will have only medium value and give no improvement over the original variety when crossed. The bulk of the germplasm in every population is mediocre. Of necessity only the exceptionally few will give outstanding results. For these reasons the outcome of selection in self-fertilized lines depends upon how extensively and skillfully it is applied.

Possibility of Obtaining Vigorous Inbred Strains.

Most of the inbred strains of corn so far produced have been reduced to about fifty per cent. or less of the production of the original cross-bred varieties. Some strains have failed to reproduce after one generation of self-fertilization. Others have persisted in a weakened condition for several generations and then perished. Still other strains are able to survive, but are continued only with the greatest difficulty. The majority of the self-fertilized lines, when uniformity and fixity of type are reached, are about one-third as productive as at the start. A few are exceptionally good. They grow more vigorously and yield more than the rest and are equally uniform and fixed in their type. But even the best of these are still below the original variety in amount or quality of grain produced. On the basis of hybrid vigor being due to dominance of the more favorable factors it is theoretically possible to secure inbred strains that will show little or no reduction in vigor, and a few may sometime be obtained that are even

more vigorous and productive than the cross-bred variety. This is deduced from the fact that most heterozygous combinations of factors are less effective than the homozygous combinations of the same factors. Thus the cross of yellow and white corn gives a lighter color than pure yellow. The cross between a determinate growth type of tobacco with an indeterminate growth type (Jones, 1921) which involves a single factor, differs from either parent in size of plant and number of leaves. Dominance is seldom perfect and while there is little direct evidence in this respect for characters

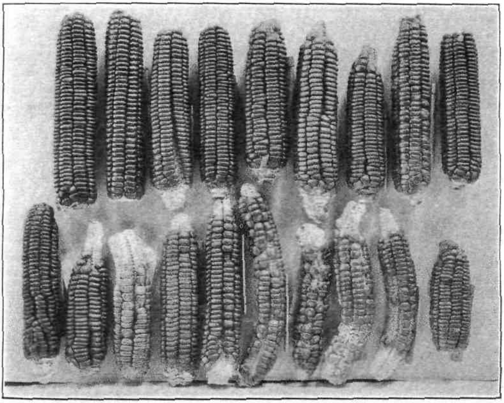

Figure 36. Self-pollinated ears grown on selected plants of Gold Nugget, No. 105. Each ear is the starting point of a selected line. These are numbered 2 to 10, top row, and 11 to 20 bottom row, left to right. (Ear 1 was shelled before photographing. It was similar to No. 2.)

which directly affect vigor there is every reason to expect that a homozygous combination of all the more favorable dominant growth factors will make possible a greater development than the heterozygous combinations of the same factors with weaker allelomorphs. However, as just noted, certain results are obtained from heterozygous combinations that can not be obtained from either factor alone. If there are many of these that play a part in growth vigor, then heterozygosity may be indispensable to maximum development. Moreover, recombinations of large number of

factors are extremely difficult to obtain and since favorable and unfavorable growth factors are distributed indiscriminately throughout the hereditary mechanism the chances of securing self-fertilized strains of corn which equal the cross-bred varieties are so exceedingly small that there is little hope of obtaining them. The most that can reasonable be expected are inbred strains which are appreciably better than any that have so far been produced. The results that have already been obtained from self-fertilizing corn, and the theoretical possibilities, some of which may be attained in the future, are shown diagrammatically in figure 34.

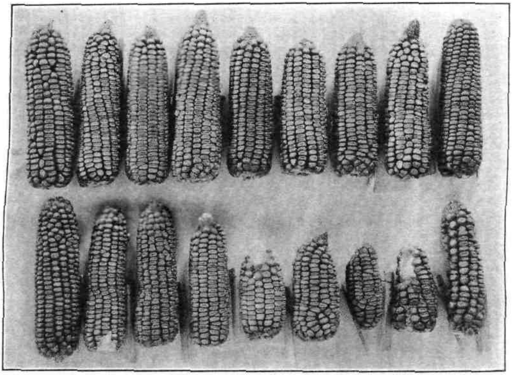

Figure 37. Self-pollinated ears grown on selected plants of Century Dent, No. 110. Each ear is the starting point of a selected line. These are numbered 1 to 9 top row and 10 to 18,bottom row, left to right.

Selection in Self-Fertilized Lines.

To demonstrate the value of inbreeding as a means of isolating good heredity a system of selection in self-fertilized lines was begun in 1918. Four varieties of corn were chosen as material with which to work. These varieties have been grown in Connecticut for many years and are well adapted. In a variety test of long duration they have proven to be among the best in production of grain and in other qualities. The four varieties are as follows:

Burwell's Yellow Flint, No. 30 and No. 40. An eight rowed yellow corn of the Canada Flint type. The ears are medium in size, one or two on the stalk. The plants are medium in maturity.

Gold Nugget, No. 105. An eight rowed yellow flint corn with large ears, broad kernels and heavy cobs. The stalks are large with few suckers. The plants mature late in the season.

Century Dent, No. 110. A light yellow dent corn with broad, smooth, shallow dented kernels. The ears are medium in size and have from 14 to 18 rows. The plants are medium in size and mature well in practically every season.

Beardsley's Leaming, No. 112. A yellow dent corn with tapering ears with 16 to 22 rows and small, shallow kernels. The stalks are large. This variety is later in maturing than Century Dent and is usually more productive.

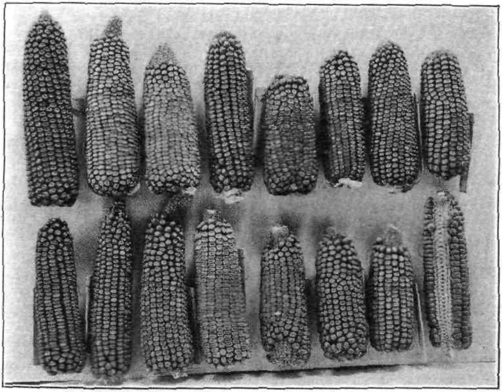

Figure 38. Self-pollinated ears grown on selected plants of Beardsley's Leaming, No. 112. Each ear is the starting point of a selected line. These are numbered 1 to 8, top row, and 9 to 16 bottom row.

The plan of procedure was to self-fertilize a number of the best plants in each of these four varieties and to use each of these plants as the starting point of an inbred line. These lines were to be continued by self-pollination of the best plants in each generation until uniformity and constancy were reached. Accordingly from about 60 plants each of the four varieties grown from a general mixed lot of seed, 20 plants of each variety were selected at pollinating time and self-fertilized. These four lots of ears are shown in figures 35 to 38. Some of the self-pollinated plants

failed to set seed but all of the ears that had enough seed to work with were planted. The original hand-pollinated ears were ranked according to their appearance in size, form of the ear and quality of the seed. Ear number one represents the best, number two the next best and so on down. The ear numbers became the numbers for the self-fertilized lines derived from them. Therefore, the number of the line shows how its original progenitor was classified. It is of considerable interest to note to what extent good strains can be obtained from unpromising ears at the start.

Each self-pollinated ear was planted in a row the following year and five plants of each were again selected at pollinating time as the most desirable and were self-fertilized. It was noted that the best appearing plants at the time of pollination were not always

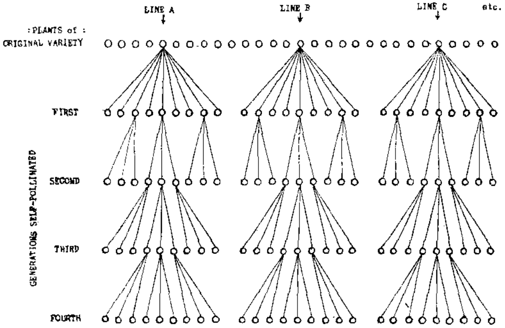

Figure 39. Diagram of a method of selection in self-fertilized lines. An individual plant becomes the starting point of each inbred strain. Three progenies are grown but only one is selected to continue the line.

the most productive at maturity. For this reason more plants were self-pollinated than there were progenies planted, thus allowing for some failures of pollination and also to permit of some selection among the hand pollinated ears. Also, in order to base selection upon progeny performance rather than upon the appearance of the seed ear, three progenies from each line were grown each year. At pollinating time the best appearing progeny was chosen and five plants were again self-fertilized, the other two progenies being discarded. This method of carrying on selection is shown diagrammatically in figure 39.

About thirty plants were grown in each progeny. From three to five times this number of seeds was planted and the poorest

seedlings pulled out after they were well started, leaving the tallest and most vigorous plants. An even stand was obtained in most cases. The end plants in each row were usually avoided in selecting the plants for hand-pollination as these are nearly always larger and better developed than the others on account of their better opportunity to grow.

METHOD OF POLLINATION.

The plants were pollinated by hand as shown in figures 40 and 41. The general method used is as follows:* A three pound manila grocer's bag is placed over the ear shoot before the silks appear. The tassels are covered with an eight or ten pound bag as soon as they are above the upper leaves. When the silks are about three-fourths out, pollen is dusted over them and the tassel bag placed over the ear. Care is taken not to touch the silks or the inside of the tassel bags with the hands in order to avoid contamination with foreign pollen. If the silks extend more than three or four inches beyond the tip of the ear they are cut back with a knife sterilized in alcohol. After the first generation or two, out-crossed plants can be easily noted by their much greater size and darker green color so that contaminating pollen is not a cause for great concern. Effort is made to pollinate as rapidly as possible. Only one application of pollen is made. If sufficient seed does not result from this application the ears are not used. Some good plants are lost because all the pollen has been shed and has lost its viability before any silks appear. This tendency to protandry is accentuated in some inbred lines. Such strains could be maintained by sib-crossing but since this method of inbreeding is much less effective than self-fertilization in bringing about homozygosity the latter system has been rigidly adhered to. In this way sterility and recessive abnormalities of all kinds are most quickly eliminated.

SELECTION OF EARS FOR PLANTING.

Each hand-pollinated plant is tagged with a printed form upon which notes as to the character of the plants in the field and the hand-pollinated ears when mature are entered as follows:

Pedigree number
Field plot number
Height to ear-bearing node
Height to first branch on tassel
Number of ears containing seed
Number of leaves
Number of tillers
Posture, whether erect, leaning, bent, broken or fallen
Color and markings of foliage
Infection on plant
Smut on ear
Mold on ear
Number of rows of grain on ear, regularity of rows, and length of ear
Color and general character of seeds
Color and shape of cob.

* A method of pollinating proposed by Jenkins and known as the "bottle method" was also tried. Under our conditions it did not prove as satisfactory as the procedure described here.

At harvest these tags are transferred to the hand-pollinated ears. In choosing the three ears for planting in each line, from the five ears pollinated, the characters of the plants in the field as well as the size and appearance of the ears are taken into consideration, chief attention being given to ability to stand erect, color of foliage, freedom from smut and other infection on the plant and ear and absence of mold on the ears.

ELIMINATION OF SELF-FERTILIZED LINES.

In all, 86 self-fertilized lines were started, distributed among

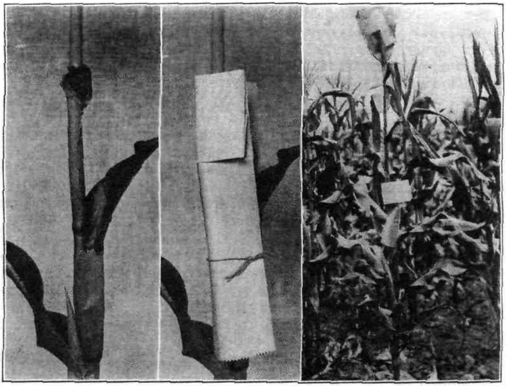

Figure 40. Plant bagged for hand pollination. Small bags can be used over the ear shoot and the tassel bag placed on the ear when pollinated. Wire clips are now used to hold the bags on the ear and tassel.

the four varieties as follows: From Burwell's Yellow Flint number 40 there were 18 ears self-pollinated in 1918, ranked and numbered from 1 to 18 in order of their excellence as shown in figure 35. In addition to these there were 14 ears of the same variety which had been self-fertilized in 1914 for another purpose and not used. These were included among the Burwell strains with the variety number 30 to distinguish them from the other strains which were ranked according to their appearance. The fact that these ears had been held five years before planting has interest in connection with the possible elimination of abnormal-

ties due to the age of the seed, as will be noted later. From the Gold Nugget variety, number 105, twenty lines were started (figure 36); from Century Dent, number 110, eighteen lines (figure 37), and from Beardsley's Leaming, number 112, sixteen lines were started (figure 38).

The once self-pollinated ears beginning these 86 lines were planted in 1919 and hand-pollinated ears were obtained from all lines except one in Gold Nugget and two in Century Dent. These failures to produce seed in all five pollinations in each line may have been due to delayed pollination and unfavorable weather conditions. But since good ears were obtained in the other lines

Figure 41. Pollinating corn. Only one man is necessary for this operation. Care is taken not to touch the silks or the inside of tassel bag. If the silks are more than three inches long they are cut back to about one inch with a knife sterilized in alcohol.

it is fair to assume that these lines were less vigorous or for some reason were not as able to reproduce under this method of pollination. In the second generation two more lines were lost because no self-pollinated seed was obtained. In the third generation four lines were discontinued. In two of these no hand-pollinated ears were obtained, and the other two were so badly damaged by mold that they were discarded.

In the fourth generation eleven lines were eliminated. Nine were discarded because they were so very poor and unpromising

that it was thought advisable not to carry them further. Some of these failed to produce any seed on any plants. All of the hand-pollinated ears of two lines proved to be out-crossed, due possibly to the fact that the bags covering the ears of the previous generation were broken and allowed foreign pollen to enter. By the fifth generation practically all of the lines had become uniform and stable. All that had survived up to this point gave promise of being able to continue indefinitely if sufficient effort was put forth and provided the season was not too unfavorable. During the course of the five-year selection period the following lines were eliminated for various reasons:

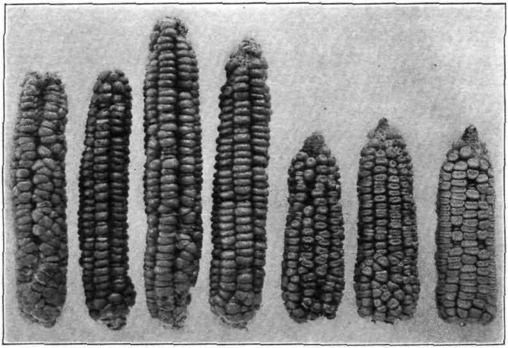

Figure 42. Self-fertilized ears showing defective or aborted seeds.

In No. 30, line 2 was accidentally lost.
In No. 40, lines 2, 5, 11, 12, 17, 18 were discarded.
In No. 105, lines 1, 4, 5, 12, 19 were lost or discarded.
In No. 110, lines 8, 12, 13, 14 were lost or discarded.
In No. 112, lines 2, 5, 11, 13 were discarded.

In all, 20 lines were not continued to the end of the fifth generation. Three of these were accidentally lost thru no fault of their own. The others were too poor to be carried along. An examination of the original ears from which these lines came (figures 35 to 38) shows no marked relation between their poor behavior and their appearance when first pollinated. Dividing each lot of ears into two equal groups and not counting the three lines that were

accidentally lost, we find that seven from the best appearing lines at the start were discarded and ten from the poorest.

The original plan was to keep all lines that could be successfully propagated even though they became extremely poor. It was fully appreciated that inbred strains may themselves be very

Figure 43. Seedlings lacking chlorophyll are common hereditary variations in corn.

undesirable and still have potentially great value when crossed with other strains. For this reason no lines were discarded unless the amount of seed produced was so small that enough plants to permit satisfactory measurements could not be grown. Many lines were continued which were extremely weak, unproductive and showed markedly undesirable characters. They were continued

to compare them in crossing with other strains. The results of these comparisons will be reported in a later publication. It should be emphasized here that the 20 lines, or 23 per cent. of the original number, which were lost or discarded, represent for the most part extremely poor and undesirable material that would probably be lost in any selection experiment. By growing a larger number of plants in order to give a greater opportunity for selection and by hand-pollinating a larger number of individuals it would probably have been possible to continue many of these lines and some might even have turned out to be good strains in the end. Whether it is worth while to work more intensively with a few lines or expend the same amount of time on a larger number of strains less intensively selected is one of the most important problems to be considered.

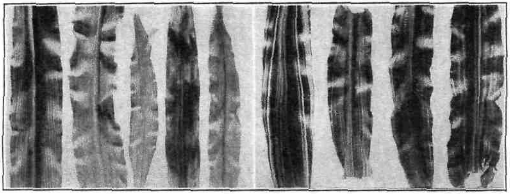

Figure. 44 Various types of chlorophyll deficiencies found in inbred strains of corn.

THE PRODUCTION OF ABNORMALITIES

An examination of the original ears after the first self-fertilization (figures 35 to 38) showed eight that were segregating for small, dull colored seeds that were clearly abnormal. These recessive seeds varied on different ears from almost entirely empty pericarps to seeds nearly normal in size but shriveled and opaque in appearance, as shown in figure 42. These aborted seeds, in most cases, failed to grow and those which did germinate, produced abnormal seedlings none of which reached maturity. The normal seeds from ears showing defectives when planted produced segregating ears on some of the plants in the following generation. In addition, five ears which were not clearly segregating in the first generation produced some ears with abnormal seeds in their second generation progenies. It has since been found that this defective seed condition is due to a large number of lethal or semi-lethal factors which are hereditarily distinct. They are widely distributed in all kinds of corn. In cross-pollinated plants only a few of these abortive

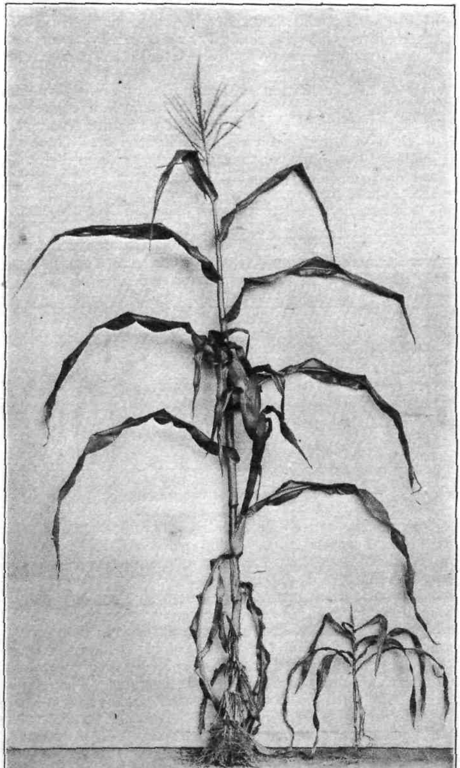

Figure 45. A chlorophyll-deficient dwarf compared to a normal plant in the same family.

seeds are seen on any ears and these are not conspicuous. It is quite possible that the plants carrying these factors in a heterozygous condition may be seriously weakened by them and for that reason the elimination of these lethal endosperm factors is probably important.

When the first generation self-fertilized ears were grown, chlorophyll-deficient seedlings appeared as Mendelian recessives in fifteen lines. Eight of these segregated for white seedlings, one yellow, three yellowish green and three light green. These abnormal seedlings were quite distinct and most of them died as soon as the food stored in the seeds was exhausted. Several distinct types of striped and variegated plants which represent various forms of chlorophyll deficiency were observed and are shown in figure 44.

Other clear-cut abnormalities which appeared in the first generation as recessive segregates were golden plants in four lines, various forms of dwarfs in three lines, sterile tassels which pro-

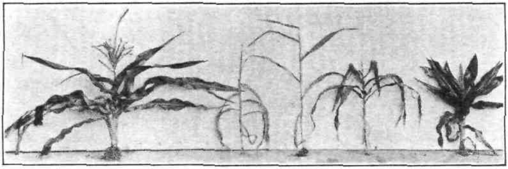

Figure 46. Various types of dwarfs found in inbred strains of corn.

duced no pollen in five lines. Barren plants without ears and which had the appearance of being simple Mendelian recessives were found in three lines but the inheritance of such sterility factors has not been definitely proven.

In addition to these common abnormalities some new characters were found which had not been observed in other material. A few plants of one line bore ears with no silks and such plants were therefore entirely sterile in the pistillate parts as shown in figure 47. Good pollen was produced and when crossed on to normal plants the silkless ears reappeared in later generations. This character was not found until the second generation. It may have occurred the first year and been overlooked. Another strain produced square cobs and another had ears with many silks in place of one for each seed. This latter character failed to reappear in later generations and apparently was not inherited, or at least not as a simple recessive. Many other variations from normal occurred. They differed in degree of abnormality, some affecting the plants much more seriously than others.

In twelve lines no abnormalities were noted in the first two generations, but in the third or fourth generation, various types appeared, in the form of chlorophyll-deficient seedlings, striped and variegated plants, dwarfs, seedlings with tube leaves instead of normally flat, and plants with only the mid-ribs in place of normal leaves. In some of these cases recessive segregates may not have appeared in the first generations on account of elimination due to poor germination or they may have been thinned out with

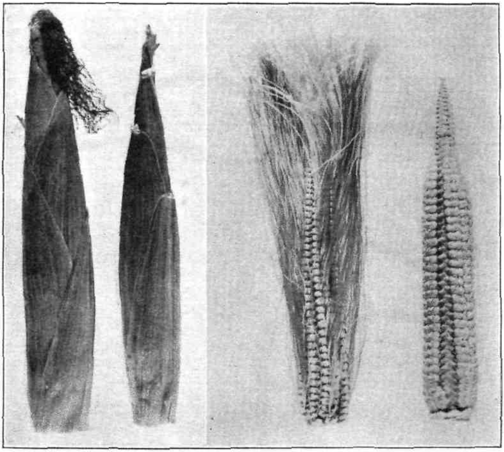

Figure 47. Silkless ears compared to normal specimens from the same family.

the weaker seedlings. In some cases, however, there seems to be no question that they are due either to original mutations or to delayed segregation resulting from some complicated mode of inheritance. A good illustration can be given in the production of the narrow-leaved plants shown in figure 48. Such a striking variation as this could not be easily overlooked. All the selected lines were carefully examined for abnormalities throughout the season, beginning with the early seedling stage. Narrow-leafed plants were first observed in the third generation in lines 112-13

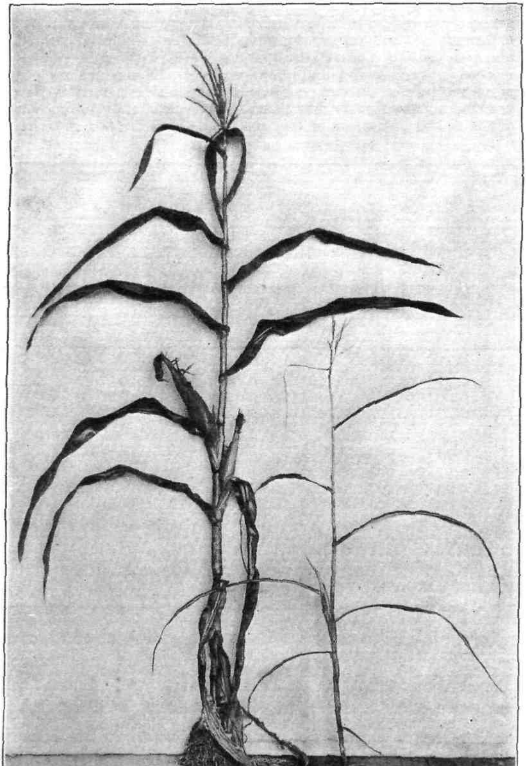

Figure 48. Plants with narrow leaves occurred in two inbred lines.

and 112-14. All three progenies of 112-13 produced some abnormal plants; two, nine and eleven narrow-leafed individuals appearing in the different progenies in a total of about 25 plants in each. This line had been segregating previously for dwarfs, golden plants, yellowish seedlings and striped dwarfs. Line 112-14 produced one narrow-leafed plant in the third generation. Though only normal plants were self-pollinated in the third generation, all of the fourth generation plants in line 112-13 were abnormal, being short and with streaked and wrinkled leaves varying in width from a mere mid-rib to nearly full width. The plants were so poor that no self-pollinated ears were obtained and the line was lost. Line 112-14 produced no narrow leaves in the fourth generation. All the plants were described as uniform, leafy but short in stature. In the fifth generation three progenies, all from ears borne on normal plants in the fourth generation, were grown. No plants were obtained from one and only a few in the other two. All of these had typical narrow leaves and were badly stunted. They made a feeble growth and produced no ears.

Pollen from typical narrow-leafed plants of the third generation out-crossed on to normal plants failed to show any abnormal plants in either the first or the second generation. Five self-fertilized progenies of the third generation were grown and in about 30 plants one narrow-leafed plant was found. The inheritance of this abnormality is not understood.

In the fourteen lines of Burwell's Flint which came from ears self-pollinated in 1914 and not planted until 1919 no abnormalities of any kind were noted in the first two generations. In the third and fourth a few chlorophyll-deficient seedlings, striped plants and tube leaves appeared. In contrast to this are the 18 lines of the same variety self-pollinated in 1918 and planted the following year which segregated the first generation for defective seeds, dwarf plants and chlorophyll-deficient seedlings in five lines. Five other lines of this lot were so poor they were discarded, while none of the 1914 lot were eliminated. Though the number of lines is too few to be conclusive it seems that the delay of five years in planting may have eliminated many abnormalities by the death of the seeds carrying them. A germination test of these ears, made in 1919, showed a viability ranging from 10 to 100 per cent. Eight of the 14 ears germinated 90 per cent. or less. None of the one year old self-pollinated ears of the same variety germinated less than 85 per cent. and only two were less than 95 per cent. There was clearly an elimination of seeds in the five-year resting period and this could easily have been selective, the seeds carrying the recessive abnormalities being less viable. If this is proven to be the case, some method of destroying the less viable seeds such as exposure to high temperature, alternate germinating and drying or similar harsh treatment may be an effective means of weeding out defective germplasm.

Many of these recessive abnormalities after they once appeared,

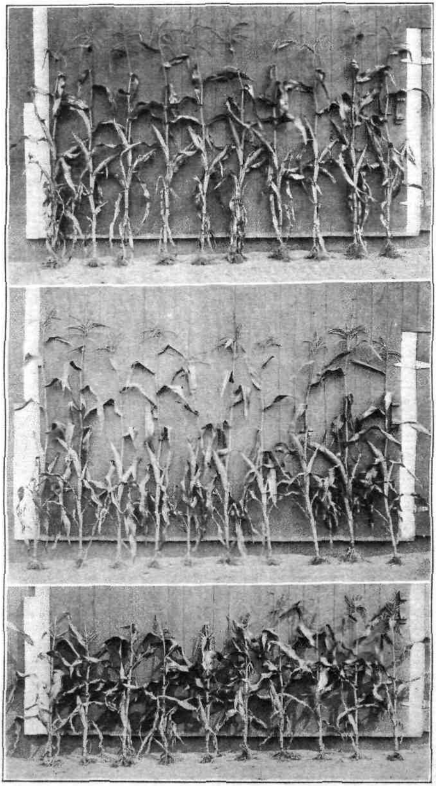

Figure 49. Representative plants of three flint lines; from top to bottom they are 40-4, 105-10, and 105-20.

kept reappearing in the following generations, but were finally eliminated, in every case except one, by the fifth generation. One line which was vigorous and productive and quite uniform in the fifth generation has segregated for white seedlings in every generation. Selection of progenies has usually been based upon productiveness and general appearances of the plants without regard to whether they were segregating for abnormalities or not.

Out of the original 86 lines only 32 lines or 37 per cent. showed no clear-cut recessive abnormalities during the five generations they were self-fertilized. As stated before, 13 lines or 15 per cent. segregated for defective seeds, and 15 lines or 17 per cent. for chlorophyll-deficient seedlings. Many of the lines had several types of abnormality. In a lot of 575 self-fertilized ears from six varieties of white flint corn in another selection experiment there were found 19 ears or a little more than 3 per cent. segregating for defective seeds. Of these, 441 were grown and 40 lines or 9 per cent. were found to be segregating for chlorophyll-deficient seedlings. Hutchison self-fertilized 2,110 ears from a large number of different varieties of corn commonly grown in various parts of the country and found 3 per cent. segregating for defective seeds and 36 per cent. for various seedling characters, of which the greater number were chlorophyll deficiencies.

The widespread occurrence of these recessive abnormalities is fully established. In normally cross-pollinated plants they are comparatively rare in appearance since they are present as recessives in the heterozygous condition. To what extent, if any, they reduce growth in the heterozygous condition has not been established. Lindstrom (1920) suggests that in eliminating these recessive abnormalities many desirable factors with which they are linked may also be taken out. Since these recessives are presumably scattered throughout the chromosomes many other factors both good and poor will be taken out with them.

It has been argued that the recessive abnormalities tend to be eliminated by natural selection except in those cases where they happen to be closely linked with exceptionally favorable growth factors, in which case they would be preserved, and in weeding them out the factors which promote growth would be lost with them. The only answer to such an argument is to see what the facts are. Twenty-five lines segregating for clear-cut abnormalities gave progenies in the following generation, some with and some without the recessives. The 25 progenies which still carried the recessives averaged 50.8 bushels per acre yield in comparison with 50.4 bushels for the 25 progenies grown in the adjoining rows, and from which the abnormalities had been eliminated. An equally good stand was obtained in each case, as an excess of seed was planted and the recessive abnormalities thinned out. The difference in yield in the two lots is not significant. If there are favorable growth factors in the segregating progenies which are not present

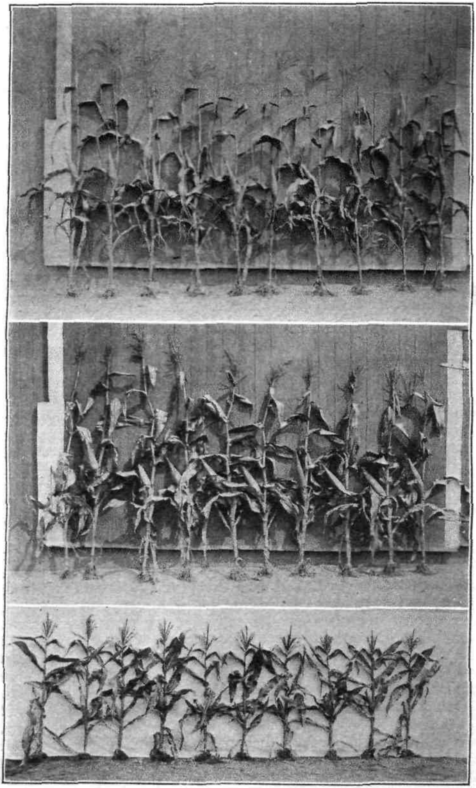

Figure 50. Representative plants of three early dent lines; from top to bottom they are 110-4, 6, 10.

in the non-segregating progenies from the same grand-parental plant they have no more effect than to counterbalance any weakening influence that the recessive abnormalities may have in the heterozygous condition.

Another comparison is made by finding the average per cent. reduction in yield of all segregating lines from the first generation to the fifth generation, by which time the abnormalities were eliminated. This reduction was found to be 57.1 per cent. compared to the reduction of 58.1 for all lines which were free from abnormalities at the start. If any favorable growth factors were lost when the recessive characters were weeded out, their departure caused no greater reduction in yield than took place in the other material from which no abnormalities were removed.

From this it seems evident that the chances are no greater for good factors to be eliminated than poor ones and with other things being equal it seems highly desirable to take out these clear-cut recessive abnormalities. In fact it is necessary, in most cases, to eliminate all lethal and semi-lethal factors, in order to bring the strains to uniformity.

THE APPROACH TO UNIFORMITY AND CONSTANCY.

As expected, the first and second generations were quite variable but in the third generation, after three successive self-fertilizations, a number of lines became fairly uniform in height of plant, color of foliage and in general characteristics. In the fourth generation the majority of the lines had become well fixed in their type, and after five generations all of the selected lines, with a few exceptions, were alike within themselves. This uniformity was apparent in the plants of each progeny and in the similarity among the several progenies of the same line. A few lines remained variable throughout the five generations. As a rule the lines that showed uniformity in the third generation declined somewhat in size and yield in the two subsequent generations. Practically all of the best strains can be picked in the fifth generation. Many of them can be recognized in the fourth and a few in the third. However, it is necessary to have a record of their performance during two and preferably three seasons after uniformity is reached in order to be sure that they are fixed in their type. Several strains that were considered to be very promising in the third generation declined so in vigor and productiveness in the two following generations that they were much inferior to strains that had, earlier, been far less promising. On the other hand a few of the most vigorous and productive lines in the fourth and fifth generations were not noted as being promising in the third. While it cannot be asserted positively that strains which are uniform and good in appearance during the fourth and fifth generations will maintain themselves without further reduction the evidence from the older inbreeding experiments indicates that

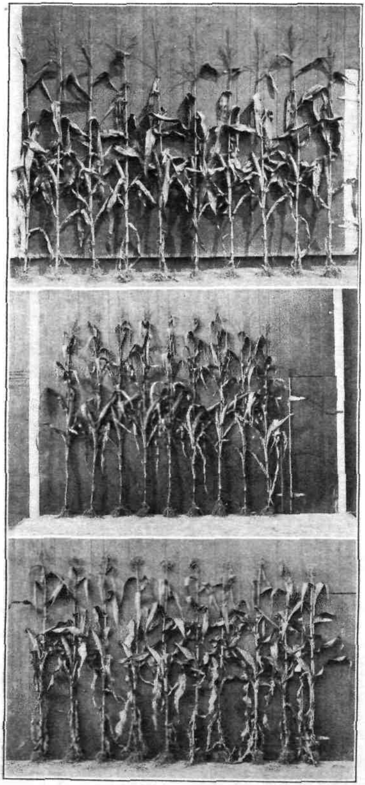

Figure 51. Representative plants of three late dent lines; from top to bottom they are: 112-1, 4, 9.

they can be expected to maintain their level of vigor without much loss. Therefore in carrying out a selection process of this kind the fourth and fifth generations are the most important in affording an opportunity to pick the best-appearing self-fertilized strains.

The selection process was carried out with the aim of securing the most vigorous and productive inbred strains, uniform and fixed in their type so that their good qualities could be maintained indefinitely. For this purpose five generations of self-fertilization are necessary in most cases.

Differences in the Selected Lines.

In the fourth generation all of the selected lines had become strikingly differentiated. Differences in height, color of foliage, size and shape of ears made each line distinct from every other line. In the Burwell Flint lines differences in average height ranged from 51 to 98 inches, in the Gold Nugget lines from 44 to 84, in the Century Dent from 44 to 76 and in the Beardsley's Leaming lines from 54 to 100. Color of foliage varied from very dark bluish green, through all gradations in shade to light green and yellowish green. In some lines the leaves were streaked with alternate rows of light and dark tissue. Various forms of fine and coarse flecking and mottling of the leaves were a regular feature of some strains while others were entirely free from this physiological irregularity of the chlorophyll.

The flint strains were most noticeably different in number of tillers. A number produced no large tillers and some had only a very few inconspicuous shoots from the base of the plants. Others branched very freely, producing many large branches on every plant. Many of these were as large as the main stalk and bore ears. Some strains regularly produced seeds in the tassels on nearly all plants while others never did this.

The ability to stand erect throughout the season is one feature that has been carefully selected for in all lines. Marked differences in this respect were shown, being greater in some seasons than in others. Certain lines regularly went down sometime during the latter part of the season while others stood stiffly erect up to maturity. Equally pronounced differences in time of flowering are shown by the lines derived from the same variety. Most of the lines matured satisfactorily every season while others were so late as to be barely able to ripen seed. The weakening effect of inbreeding delays maturity in all lines but in spite of this some were earlier in ripening than the variety from which they were derived. Along with these differences in maturity were great dissimilarities in character of the grain. The seeds of some were hard, translucent and bright colored; others were soft, dull colored and in some lines regularly moldy.

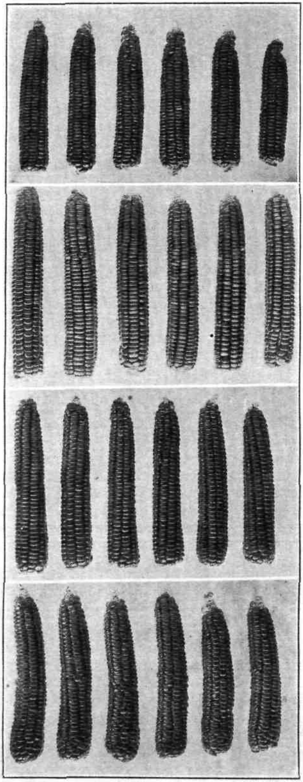

Figure 52. Representative ears of four productive Burwell Flint lines; from top to bottom they are: 30-19, 40-1, 7, 8.

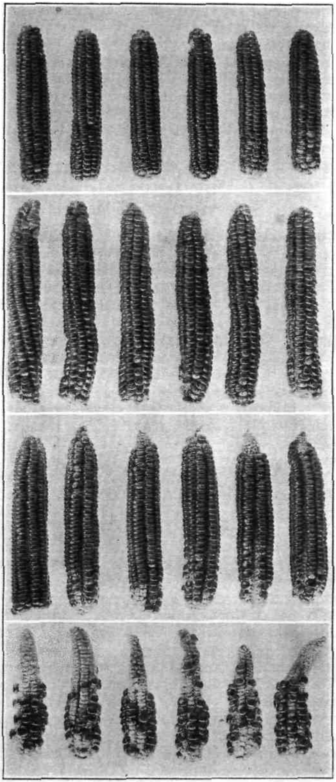

Figure 53. Representative ears of four unproductive Burwell Flint lines; from top to bottom they are: 30-5, 6, 40-15, 16.

The features named are the more striking ones. Differences in structural details are brought out in the accompanying illustrations showing the plants and ears of some of the selected lines in the fourth generation (figures 49 to 57). In details of structure and arrangement of parts the lines are so distinct that they can usually be easily recognized in the field and after harvest. In a few features certain strains may be alike. Some strains have similar plants but differ decidedly in ear structure. In others the ears are somewhat similar but are borne on markedly different plants. For the most part the differences are far more obvious than the similarities.

Susceptibility to Disease.

The most common diseases with which corn has to contend in Connecticut are smut (Ustilago), leaf blight (Helminthosporium), and various root, stalk and ear roots (Diplodea, Gibberella and other forms of Fusarium). Marked differences in smut infection were shown. Two lines 105-14 and 110-17 showed no smut infection on any plant in any progeny during the five generations they were grown. Eleven strains had no more than one plant affected in any one year throughout the same period. The place on the plant where the smut balls appeared was usually quite characteristic, some strains having them on the basal nodes, others at the ear node, still others on the leaves or tassels. In some lines numerous light infections on the plant or ears were shown which apparently did not do any serious damage. Other strains had many plants badly injured and sometimes killed outright during mid-season. The most striking case of segregation of susceptibility to parasitism by the smut fungus occured in line 110-3. In the first generation four per cent. of the plants were smutted. In the second three progenies were grown having twelve plants in each. In one progeny none of the plants had any indication of smut infection. In another all of the plants were smutted and most of them were killed during the middle of the summer. In the third progeny 27 per cent. of the plants were attacked. The original seed of the two strikingly different progenies was planted again the following year with the result that out of 57 plants of the resistant progeny, only one plant or 1.7 per cent. was infected. The smutted lot had 14 plants infected out of 31 grown, or 45.2 per cent. In the next generation no smutted plants were seen in the one line and 65.6 per cent. in the other. Marked differences were shown in the seeds of the two lines. Plants of the susceptible line were extremely weak but the seeds were normal in appearance. However the germination of these seeds was poor and in the fifth generation no plants were obtained. The resistant line produced more vigorous plants having a noticeably darker green color. All of the seeds produced on these plants were distinctly abnormal. When dry they were shriveled and discolored although not showing

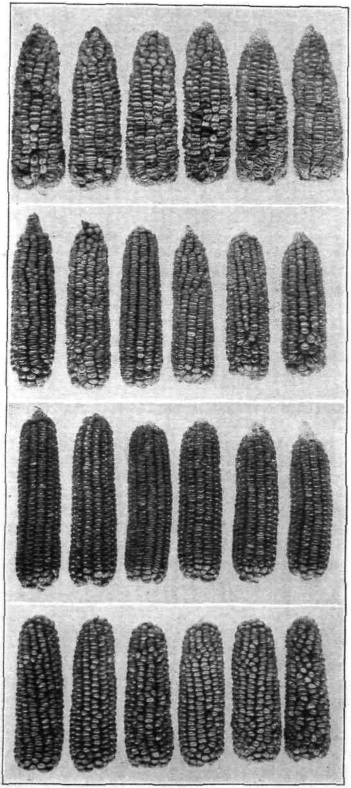

Figure 54. Representative ears of four Century Dent lines: from top to bottom they are: 110-3, 4, 5, 10.

any of the usual molds. Ears of this line are shown in figure 54. In spite of their unfavorable appearance some of the seeds germinate and the plants produced are about as good as the average inbred strain of the same variety.

None of the smut-free lines were outstandingly good in other respects and some of the most vigorous and productive strains now regularly show a high percentage of smut infection. The smut-free or low-smut strains may have value in crossing with other strains which have good qualities but are lacking in smut resistance.

The growing season of 1922 was unusually wet and the selected lines then in the fourth generation showed very pronounced differences in the amount and severity of infection of Helminthosporium. This organism, which is seldom injurious to ordinary cross-pollinated corn, readily attacks many inbred plants and on some completely kills the leaves after seed formation begins. Leaf blighting due to this organism had been noted each year in some lines but in the wet season of 1922 it was particularly injurious. Seventeen of the eighty-six lines showed heavy infection. Some of them lost all their foliage prematurely and the ears were badly stunted, the grains being small and poorly developed. Some of the most vigorous and productive strains in former years were so injured in this way as to give them a very low rating. The following year was unusually dry. Very little damage from this cause was seen, but the effect of the drought on different strains was very striking. Some strains which had always before produced green luxuriant foliage had their leaves killed at the sides and tips by the dry heat and were unproductive for that reason. Most of the strains which had been badly injured by leaf infection in the wet season were beautifully green throughout the dry period of 1923 and were among the best appearing and most promising of all the selected lines. These marked differences in different seasons makes it extremely difficult to judge the value of inbred strains and makes it necessary to test them during several years after they have become uniform and fixed in type.

The investigations of Hoffer, Holbert and others have emphasized the importance of the root, stalk and ear rot organisms attacking corn. The results of the earlier inbreeding experiments indicated that marked differences would be found among inbred plants to resist infection. Throughout the selection experiment great importance was placed on the ability of the plants to stand erect throughout the season and have the ears free from any indication of mold. Fallen plants or moldy ears were avoided whenever possible. The most outstanding differences in ability to stand erect and in freedom from mold on the ears, were seen in the third and later generations. In 1922, a wet season, four lines (30-6, 105-20, 110-2, 110-15) had all the plants of all three progenies erect throughout the season. This same year twelve lines (30-8, 30-9, 105-3, 105-18, 110-1, 110-2, 110-6, 110-7, 110-18, 112-6,

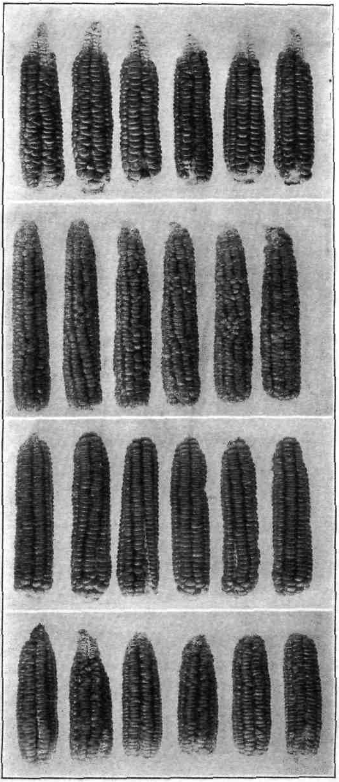

Figure 55. Representative ears of four Gold Nugget flint lines; from top to bottom they are: 105-3, 10, 17, 20.

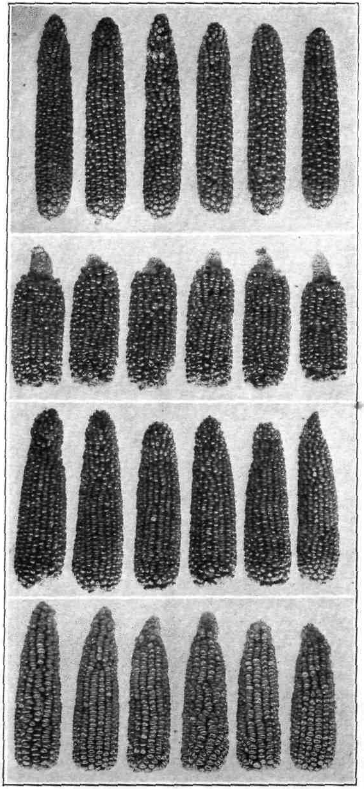

Figure 56. Representative ears of four productive Beardsley's Leaming lines; from top to bottom they are: 112-1, 4, 6, 9.

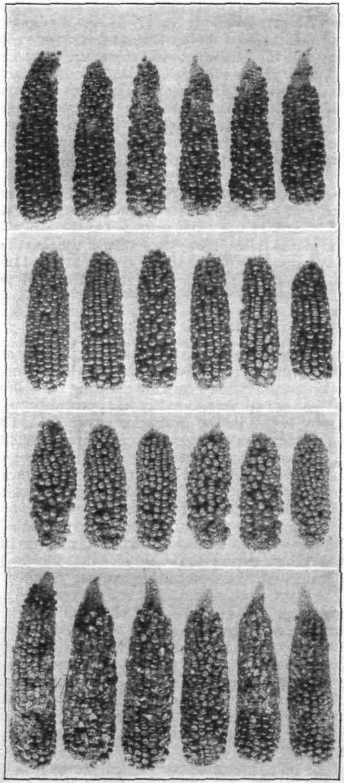

Figure 57. Representative ears of four unproductive Beardsley's Leaming lines; from top to bottom: 112-3, 10, 14, 15.

112-7, 112-8) produced no moldy ears. Only one line 110-2 had all plants erect with ears free from mold. In the first generation this line had four per cent. of moldy ears and ten per cent. of fallen plants but no smut. In the second generation there were ten per cent. moldy ears, ten per cent. fallen plants and no plants showing smut infection. In the third, fourth and fifth generations there was no mold, smut or fallen plants on the three progenies grown each year. This strain is also productive for the variety, although surpassed in this respect by several other strains. The seeds are hard and bright but very pale yellow in color and almost white on top.

In contrast to this is line 105-20 with all the plants erect in the second, third and fourth generations but with 29, 17 and 44 per cent. of moldy ears in the same years. On the other hand, 40-8 had all of the plants fallen in two progenies of the fourth generation and no moldy ears. To complete the combinations 112-11 had 87 per cent. of the plants on the ground in 1922 and 67 per cent. of ears moldy.

Criterions of Selection.

At the beginning of the selection experiment the plan as previously stated was to self-pollinate five plants in each line and to select three of the best self-fertilized ears for planting the following year. Even when these ears differed greatly in appearance no consistent differences were noted in the progenies grown from them. The coefficient of association between the appearance of the ear and yield of the different progenies within several lines is —.18. This indicates that self-pollinating a large number of ears in order to make more extensive selection of desirable looking ears is of doubtful value. Of the three progenies grown only one was to be chosen to continue the line, the other two not being pollinated. It was soon noted, however, that there was very little relation between the appearance of the progenies at the time of bagging and their production of grain and the general appearance of their plants at harvest. The coefficient of association between the appearance of the plants at pollinating time and the yield of the different progenies within the several lines is —.28. Seedlings were grown in the greenhouse and their weight and height after thirty days of growth were compared with the yield of the same progenies in the field. The third and fourth generations showed that those progenies that had the tallest seedlings yielded 1.6 bushels per acre more than the other progenies in the same lines. This difference is hardly enough to make a selection of the progenies on this basis worth while.

Since there is no appreciable correlation between the characters of the seed ear, weight of seed, size of the seedling, or the appearance of the plants at pollinating time and production of grain the only selection of progenies that can be made with any degree of

effectiveness is at maturity. Here also yield is highly influenced by the amount of heterozygosity remaining. In some lines there are more homozygous combinations than in others and they are correspondingly less vigorous and productive although they may be potentially more desirable. For this reason final judgment must be left until the plants are reduced to uniformity and constancy. Hence it is interesting to note what resemblance the resulting inbred strains, when finally reduced to uniformity and fixity of type, have to the same strains in the first generations of inbreeding.

Classification of Selected Lines.

Taking into consideration all features of these selected lines as they grow in the field and after harvest in the fourth and fifth generations and giving most importance to the production of bright sound grain, the four outstanding good and poor strains in each variety are listed as follows, with their yields in bushels per acre in the fifth generation compared with that of the original variety grown the same year:

Burwell's Flint 51.2

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
30–5	12.2	30–10	44.2
30–19	15.3	30–18	18.3
40–4	33.6	40–3	35.1
40–8	25.9	40–16	24.4

Gold Nugget 54.0

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
105–11	29.0	105–3	9.2
105–15	33.6	105–8	13.7
105–17	22.9	105–13	7.6
105–20	40.7	105–16	29.0

Century Dent 48.3

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
110–2	15.3	110–1	28.9
110–4	16.8	110–9	4.6
110–5	10.7	110–15	1.5
110–10	19.8	110–17	12.2

Beardsley's Leaming 49.5

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
112–1	42.7	112–3	10.7
112–6	27.5	112–7	21.4
112–9	33.6	112–14	.0
112–12	12.2	112–16	9.2

This is purely an arbitrary classification based upon the general appearance of the plants and ears. Some of the poor lines yielded more than the good lines but produced a very poor quality of grain. The original ears from which these lines descended (figures 35 to 38) show that there is no relation between the good and poor strains after uniformity was attained and the appearance of the seed ears from which they came. Low and high numbers are represented about equally in the good and poor strains.

Correlation Between the First and Last Generations.

In order to find out whether the elimination of the poor lines at the beginning of the inbreeding period is advisable, the correlation

TABLE VIII.

Coefficients of association between early and later generations of self-fertilized corn.

Generations Compared Variety	1–4 Height	1–4 Mold	1–5 Tillers	2–5 Smut	1–4 Yield
Burwell's Flint	.60	.89	.64	—.08	0
Gold Nugget	.35	0	.38	.38	.14
Century Dent	.80	.80	—.72	.72	.28
Beardsley's Leaming	.95	.38	.50	.20	.50
Ave. Flints	.50	.65	.55	.10	.05
Ave. Dents	.89	.63	.17	.52	.38
Average	.71	.64	.27	.27	.19

between the behavior of the plants in the first generation and the last generation has been worked out for the most important characters. In Table VIII are shown the coefficients of association

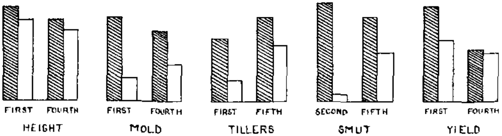

Figure 58. Diagram representing the average of the upper and lower groups in the first generations and the average of the same lines in the last generations, based on the data in Table IX.

between the first or second inbred generation and the fourth or fifth for height of plant, per cent. moldy ears, number of tillers, per cent smutted plants, and yield of grain. The fifth generation, grown in 1923, was so variable on account of the extremely dry season affecting different parts of the field unevenly that the coefficients for height and yield are based on the first and fourth generations. There was very little smut infection in the first

generation and practically no mold in the fifth so that the coefficient for per cent. smut is based upon the second and fifth generations and for per cent. mold upon the first and fourth.

The figures show a fairly high association for height of plant and moldy ears. This means that by selecting the highest lines in the first generation the resulting inbred strains in the fourth generation would tend to be taller than the average. Similarly, by selecting lines at the start that were free from mold, inbred strains could

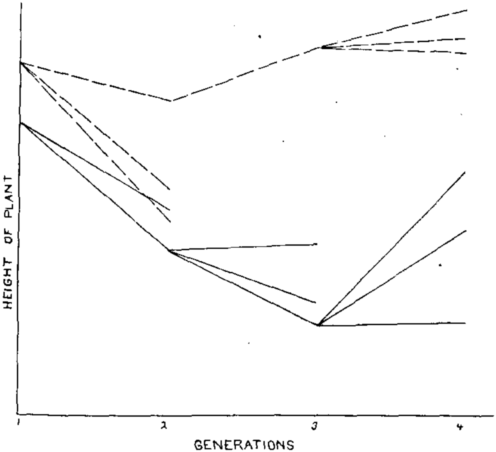

Figure 59. Graph showing the behavior of two lines with respect to height during four generations of self-fertilization, selected for vigor and productiveness but not for height. From one to three progenies are grown in each generation.

finally be attained that would on the average be freer from moldy ears than other strains which showed more mold at the start. This relation does not hold so well for the other characters; number of tillers and per cent. smut. For these the coefficients are low and in two of the varieties a negative correlation is shown. This means that lines without tillers and showing low smut infection may be obtained from plants at the start which have tillers and are susceptible to smut infection.

Another method of bringing out the relation between the several lines at the start and at the end of the selection period is to separate all the lines of each variety into the upper and lower halves, with respect to the characters studied, in the first generation and then compare the average of these two groups with the averages of the same lines after being inbred for four or five generations. This has been done in Table IX, making the separation within each variety into equal sized groups in the first generation. Thus the basis for separating the groups is the median instead of the mean. The results are summed up graphically in Figure 58. It will be seen that the relative position of the upper and lower halves remains nearly the same at the end of the period of selection as at the

TABLE IX.

The relative position of the same self-fertilized lines at the beginning and at the end of the period of selection.

Characters measured	Groups	No. of Strains First	No. of Strains Last	Average First	Average Last	Relative First	Relative Last
Height of plant in inches in the first and fourth generations	High	36	94	81	70	100	100
	Low	36	96	70	61	87	87
Per cent. of moldy ears in the first and fourth generations	High	36	88	18	15	100	100
	Low	35	95	5	8	29	57
Number of tillers per plant in the first and fifth generations	High	32	91	.9	1.2	100	100
	Low	33	94	.3	.8	36	67
Per cent. of plants with smut in the second and fifth generations	High	32	90	14	12	100	100
	Low	33	93	1	7	9	59
Yield of grain in bu. per acre in the first and fourth generations	High	31	84	81	44	100	100
	Low	31	82	52	41	64	93

beginning for such characters as height of plant, number of tillers, per cent. of moldy ears and smutted plants although the differences are generally less at the close than at the start. This tendency to change during the period of inbreeding is most marked for yield of grain. In this respect the high and low groups are very nearly alike at the end of the selection period in spite of the fact that all along attention has been given to productiveness. These results indicate that it is unwise to eliminate the unproductive strains in the first generations, as from them lines may be obtained that are as productive as those from high yielders at the start. Other characters can apparently be somewhat more surely selected for at the beginning of the inbreeding period. If such characters as freedom from mold and smut are of chief importance it might be advisable to eliminate those lines which show much mold and smut in the first inbred generations.

The general tendency for some of the lines to hold the same relative position throughout the process of selection is illustrated by the height of plant of two lines shown graphically in figure 59. In the first inbred generation the two lines averaged 69 and 77 inches in height. In the second generation two progenies overlapped but from then on they were clearly distinct, the difference in height increasing until the end of the selection period. The same result is shown in the average number of tillers per plant of two other lines as brought out in figure 60. Differing at the start the two lines remained distinctly different in all their progenies throughout the period of inbreeding. In marked contrast to this is the result shown graphically in figure 61. Two lines differing noticeably in their number of tillers changed positions so that in

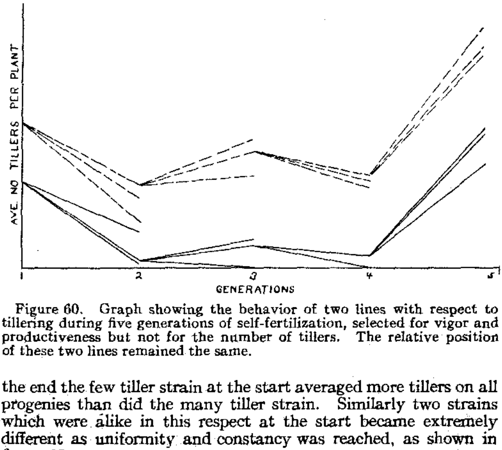

Figure 60. Graph showing the behavior of two lines with respect to tillering during five generations of self-fertilization, selected for vigor and productiveness but not for the number of tillers. The relative position of these two lines remained the same.

the end the few tiller strain at the start averaged more tillers on all progenies than did the many tiller strain. Similarly two strains which were alike in this respect at the start became extremely different as uniformity and constancy was reached, as shown in figure 62.

Limiting Factors.

In planning and carrying out a selection program the best procedure will depend upon the number of plants which can be grown and the number of hand pollinations which can be made in a season. Where the facilities available for artificial pollination is the limiting factor, and this is usually the case, the best procedure

is to self-pollinate just enough plants to continue as many lines as possible until a reasonable degree of homozygosity is reached. If the amount of land available to grow the plants is the limiting factor it would be better to pollinate a larger number of plants within each line, although extensive selection within a progeny has been shown to have little value, as the better individuals are almost certain to be more heterozygous, making it difficult to arrive at their true value. More attention should be paid to increasing the number of progenies within the more desirable appearing lines, basing selection on their behavior throughout the season and their uniformity and productiveness at maturity.

The method now being used at this station is to grow three progenies in each line and to pollinate two plants in each progeny. On the basis of the general appearance of the plants in the field and

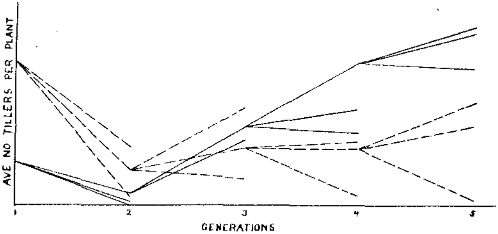

Figure 61. Graph showing two lines which differed in the amount of tillering and which changed positions during the five generations of self-fertilization.

their productiveness at maturity the best and second best progenies are noted where there is an appreciable difference. Two ears from the best progeny and one from the second best are used for planting the following year. If no differences are shown, one ear from each of the three is planted. This procedure is based upon the results in the five-year selection experiment described above in which no reliable criterions of selection were found which could be used before the time of pollination. It is still provisional and will be modified as future experience justifies. It is possible that better results can be obtained by paying still less attention to selection during the reduction period than the method outlined. By expending the same amount of time and effort on more lines, growing only one progeny in each generation and pollinating only enough plants to insure the perpetuation of the strain until uniformity and constancy are reached, more diverse material would be available

from which to select the best inbred strains. In this procedure there would be the possibility, and even probability, of missing altogether valuable material which might exist in some lines. However, since it has been shown that many of the lines change greatly during the reduction process, selection during this period will always be somewhat ineffective. From a theoretical standpoint the best method is the one which will produce the largest number of fixed strains from which to choose the ones best suited to the purpose for which they are to be used.

In this connection one further point should be mentioned. Whenever any particularly outstandingly good strain has been obtained there is the possibility that still better material may exist in that strain in the earlier generations. This would indicate that it

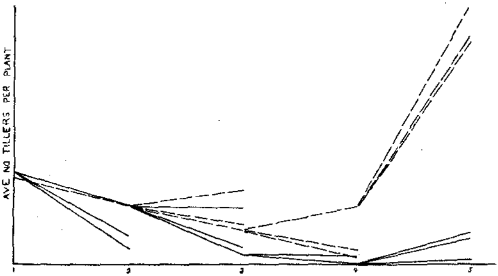

Figure 62. Graph showing two lines which showed the same amount of tillering at the start but differed widely at the end.

might be well worth while to go back to the earlier generations and grow as much of this material as possible from the remaining seed in order to obtain the very best germplasm available in this strain. In fact, this procedure has already been followed with several of the more promising lines and it has been possible to isolate new strains which are distinctly superior in some respects to the old ones.

Conclusion.

The one fact that stands out from the results secured in this selection experiment is that there is no single criterion by which high-yielding strains can be obtained. During the process of inbreeding, with the resulting segregation and recombination and the automatic elimination of heterozygous combinations of factors, selection for particular characters is somewhat effective. By

choosing tall plants as progenitors in each generation tall strains can be produced. By selecting plants free from tillers, strains with few tillers can be obtained. Similarly, freedom from disease infection, as far as resistance is inherited, can be expected by selecting during the reduction period only those plants which show no infection in fields where infection is present. Even with these characters the association is far from complete. But productiveness, yield of grain, which sums up the plant's entire energies shows no such simple relation. High yielding strains may come, and have come, from plants which are poor producers. Promising strains during the first generations may be very unproductive or undesirable in some respect when finally reduced to uniformity and constancy. This emphasizes the fact that effective selection must be based upon the performance of the plants after homozygosity is attained.

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BULLETIN 267 MARCH, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

The Twenty-ninth Report on Food Products and the Seventeenth Report on Drug Products

For

1924

By

E. M. BAILEY

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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CONTENTS AND SUMMARY.

Materials	Page	Sampled by, or at request of			Total	Adulterated, below standard, or otherwise illegal
		Station Agent	Dairy and Food Commissioner	Individuals		
FOODS.						
Carbonated Beverages	425	...	172	...	172	3
Cereal Products	426	3	1	...	4	1
Cacao Products; Cocoa, etc	426	37	1	3	41	...
Diabetic, Special and Miscellaneous Foods	429	44	...	38	82	...
Eggs	438	...	12	...	12	8
Fats and Oils:						
Butter	438	...	30	1	31	14
Olive Oil	439	...	4	2	6	2
Flavoring Extract, Vanilla	439	27	1	...	28	3
Flour, Graham, etc	442	7	5	3	15	1
Gelatin	446	...	...	2	2	...
Ice Cream	446	...	269	3	272	3
Meat Products:						
Hamburg Steak	447	...	62	...	62	22
Frankfurts	448	...	34	...	34	...
Casings	448	...	2	...	2	15
Pork Sausage	449	...	15	...	15	...
Milk and Milk Products:						
Market Milk	449	...	730	168	898	241[1]
Evaporated Milk, etc	450	1	6	2	9	...
Chocolate Milk	452	...	...	1	1	...
Cream	452	...	4	...	4	...
Buttermilk	452	5	...	...	5	...
Human Milk	453	...	...	19	19	...
Spices:						
Ground Nutmeg	454	8	...	...	8	...
Sage	454	9	...	...	9	...
Syrups:						
Maple Syrup	455	...	6	1	7	1
Molasses	456	...	20	...	20	5
Honey	456	...	1	...	1	...
Tea	456	12	...	...	12	...
Vinegar	460	...	39	26	65	4
Miscellaneous; Examined for Poisons etc	460	...	8	34	42	...
Total	...	**153**	**1422**	**303**	**1878**	**323**

[1] Official samples; includes 192 below standard only.

CONTENTS AND SUMMARY—*Concluded.*

Materials	Page	Sampled by, or at request of: Station Agent	Dairy and Food Commissioner	Individuals	Total	Adulterated, below standard, or otherwise illegal.
DRUGS.						
Tablets, Pills, etc.	462	1	91	...	92	6
Prescriptions	482	...	8	...	8	2
U. S. P. and N. F. Drugs	483	1	24	...	25	4
Toilet Preparations	485	...	17	1	18	2
Proprietary Remedies, etc.	486	10	...	...	10	3
Miscellaneous	490	...	...	14	14	...
Total	...	**12**	**140**	**15**	**167**	**17**
Total, Foods and Drugs	...	**165**	**1562**	**318**	**2045**	**340**
Babcock Glassware, etc.	492	...	...	...	3748	69

The Twenty-ninth Report on Food Products and the Seventeenth on Drug Products

E. M. Bailey

An amendment to the food and drug law of this State made about ten years ago brings medicaments dispensed by physicians within the scope of drug control. Such medicaments are very largely in powder, tablet, or pill form and the chief feature of drug inspection during the past year has been a study of the variations in medicaments in pills and tablets as dispensed by physicians. A number of prescriptions and proprietary remedies have also been examined. A shortage in the supply of vanilla beans and the prevailing high prices of the raw material suggested a study of commercial vanilla extracts, and complete analyses of the principal brands found on sale have been made. Cocoa, graham flour, spices, so-called diabetic foods, and miscellaneous natural foods are other food items of interest.

The total number of samples is somewhat less than the average for a number of years past, due to the smaller number of milk samples submitted by the Dairy and Food Commissioner, but the amount of work involved has been greater on account of the difficult and time-consuming analyses of medicinal preparations and the detailed analyses of certain food products. Considerable time has been spent in studies of methods of analysis, chiefly in collaboration with the Association of Official Agricultural Chemists; and cooperation with the Council on Pharmacy and Chemistry of the American Medical Association has been continued.

Credit for the analytical work herein reported is due entirely to Messrs. Andrew, Shepard, Fisher, Nolan and Mathis. Miss Bacon has assisted materially in preparing this and other reports for publication.

I. FOODS.

Carbonated Beverages.

The use of saccharin as a sweetening agent in soft drinks is illegal in this State. One hundred and seventy-two samples were submitted by the Dairy and Food Commissioner and only three were found to contain saccharin. This is about 1.7 per cent. of the total number as compared with 40 per cent. in 1920 and 20 per cent. in 1921. Saccharin was found in about 16 per cent. of samples examined in 1923 but the adulterated samples represented the products of only five manufacturers.

The three samples containing saccharin were as follows:

No.	Brand.	City or Town.	Manufacturer.
28162	Cream Soda	*Bridgeport*	Central New York Bottling Works.
28402	Strawberry Soda	*Danielson*	Danielson Bottling Works.
27870	Cream Soda	*New Haven*	Hamilton Bottling Works.

Cereal Products.

434 *Edgemont Crackers.* The Greer and Green Co., Dayton, Ohio.

437 *Triscuit.* The Shredded Wheat Co., Niagara Falls, N. Y.

438 *Muffits.* Muffits Corporation, Batavia, N. Y.

Analysis of these products are as follows:

No.	434	437	438
	%	%	%
Moisture	5.86	8.91	9.55
Ash	2.88	1.68	1.70
Protein (N. x 6.25)	10.00	11.47	11.97
Fiber	0.58	2.23	2.47
Nitrogen-free extract:			
Starch	59.20	56.69	52.45
Soluble carbohydrate	3.23	4.73	7.58
Undetermined	7.24	12.36	12.59
Fat	11.01	1.93	1.69

A sample of whole grain wheat, **27900** was submitted by the Dairy and Food Commissioner and an analysis already made and published[1] was reported.

Cocoa, Etc.

Cocoa is chocolate from which a portion of the fat has been removed, and, on a moisture and fat-free basis, should contain not more than 8 per cent. of ash, not more than 0.4 per cent. of ash insoluble in acid and not more than 7 per cent. of crude fiber. The term "breakfast cocoa" designates cocoa containing not less than 22 per cent. of fat. Cocoas are sometimes treated by a special process of alkalizing which darkens the color, develops a characteristic flavor and produces a product which remains in suspension longer when prepared for drinking. These are the so-called Dutch or Dutch process cocoas; they are sometimes, but erroneously, called "soluble" cocoas.

Of the plain cocoas, i. e., non-alkalized and unsweetened, given in Table I, all are substantially within the limits of the standard when calculated to moisture and fat-free basis; no fiber content is greater than 7 per cent. and no insoluble ash exceeds 0.4 per cent., excepting **20413** which slightly exceeds that limit. One total ash exceeds 8 per cent. by an insignificant amount, 0.03 per cent.

Three of the four cocoas designated as "breakfast cocoa" contained over 22 per cent. of fat.

Alkali treated or Dutch process cocoas are labeled to show that the mineral constituents are increased by from 1 to 3 per cent. The ash in such products is likely to exceed 8 per cent. and did exceed that figure in all cases, except **21706**, as shown in the tabulation. The range in ash content on the moisture- and-fat-free basis for the products examined is 7.63 to 12.25 per cent.

In addition to the samples listed in the table, two others were examined which require no particular comment.

[1] Conn. Exp. Sta., Bull. 210, p. 204 (1918).

TABLE I. ANALYSES OF COCOA, ETC.

Sta. No.	Manufacturer and Brand	Water	Ash	Ash insol. in acid	Nitrogen	Crude fiber	Fat
		%	%	%	%	%	%
20424	Walter Baker & Co., Ltd., Dorchester, Mass., *Baker's Breakfast*	5.35	5.07	0.09	3.59	3.82	26.33
21698	Conn. Butter Co., Hartford, *Reliable Breakfast*	5.37	5.10	0.02	3.80	4.40	23.75
21687	The Massachusetts Chocolate Co., Boston, *Wan-Eta Breakfast*	7.13	4.85	0.19	3.62	4.78	22.82
21648	Northern Pacific Grocery Co., Bridgeport, *Perfection Breakfast*	5.94	5.68	0.16	3.61	4.93	20.61
21704	Boston Butter House, Waterbury, *Boston Butter House*	5.09	4.92	0.03	3.70	4.50	22.58
21642	Brewster Son's Co., Newark, N. J., *L. B. C.*	5.48	5.70	0.20	3.62	3.32	20.78
21683	Direct Importing Co., Boston, *Benefit*	4.76	4.94	0.15	3.80	4.55	22.93
20419	Grand Union Tea Co., Brooklyn, N. Y., *Grand Union*	5.02	5.52	0.14	3.79	4.50	21.22
21656	The Great A. & P. Tea Co., N. Y., *A. & P.*	5.03	5.49	0.11	3.71	4.83	21.81
20410	The Great A. & P. Tea Co., N. Y., *Red Front*	5.68	5.23	0.08	3.72	4.78	21.33
20416	Hershey Chocolate Co., Hershey, Pa., *Hershey's*	5.80	4.90	0.02	3.70	4.11	23.88
21644	Howland Dry Goods Co., Bridgeport, *Crown*	4.78	5.10	0.01	3.84	4.72	27.75
21646	Huyler's, N. Y., *Huyler's*	5.73	5.25	0.18	3.74	4.34	24.18
20418	International Sugar Corp., *Cuba*, Pure Cocoa	5.80	3.32	0.13	3.67	4.58	22.18
21625	A. E. Lamb, New Haven, *Lamb's Quality*	4.95	5.25	0.04	3.80	4.58	23.47
20413	F. L. McClellan, East Hartford, *My Own*	7.87	5.70	0.36	3.37	5.05	20.07
21632	The Mohican Co., N. Y., *Mohican*	6.08	5.08	0.21	3.55	4.55	22.57
21673	Page & Shaw, N. Y., *Natural Cocoa*	5.48	5.30	0.10	3.66	4.00	24.61
21675	Park & Tilford, N. Y., *Park & Tilford*	4.98	5.65	0.07	3.91	5.01	19.09
21617	John A. Pilgard Co., Hartford, *Sterling*	5.13	5.10	0.01	3.94	4.47	22.54
21652	Royal Cocoa Co., Jersey City, N. J., *Economy*	6.98	5.72	0.19	3.55	4.77	23.07
21655	Runkel's N. Y., *Runkel's*	6.55	4.94	0.07	3.59	4.67	22.50
21627	The Stollwerck Chocolate Co., Stamford, *Gold Brand Milk Cocoa*	6.56	5.60	0.15	3.78	2.81	22.46
21709	James Van Dyke Co., N. Y., *Ambassador*	6.51	4.75	0.10	3.56	4.65	21.75

TABLE I. ANALYSES OF COCOA, ETC.—*Concluded.*

Sta. No.	Manufacturer and Brand	Water	Ash	Ash insol. in acid	Nitrogen	Crude fiber	Fat
		%	%	%	%	%	%
21688	Stephen F. Whitman & Son, Inc., Philadelphia, *Instantaneous Sweet Chocolate*	1.83	1.57	0.08	1.12	1.41	21.99
21686	The Williams & Carleton Co., Hartford, *William's* Cocoa	7.39	4.79	0.08	3.48	4.51	20.40
21622	Stephen L. Bartlett Co., Boston, *Havsome*[1], Sweetened Skim Milk Cocoa	3.67	3.70	0.00	2.09	0.84	6.90
21712	Stephen L. Bartlett Co., Boston, *Hollandia*[1] Cocoa and Chocolate Sweetened	3.04	3.19	0.02	1.68	1.96	8.02
20417	Beacon Chocolate Co., Boston, *Ace High*[1]	6.64	6.38	0.12	3.59	4.73	20.88
21670	Bensdorp's Amsterdam Holland, *Royal Dutch*[1]	5.86	6.83	0.08	3.35	4.26	29.04
21711	Droste's Cocoa Works, Haarlem, Holland, *Droste's*[1]	6.11	7.81	0.04	3.30	3.78	23.65
21660	Thomas J. Lipton, Inc., *Lipton's Instant Cocoa*[1]	5.29	5.76	0.12	3.60	4.68	23.79
21659	Royal Cocoa Co., New York, *Royal*[1]	6.63	6.47	0.09	3.57	4.81	22.65
21690	C. J. Van Houton, Holland, *Van Houten's* Cocoa[1]	6.52	8.25	0.06	3.42	4.60	26.16
21630	H. O. Wilbur & Sons, Inc., Philadelphia, *Wilbur-Dutch*[1]	7.67	5.92	0.05	3.79	4.02	20.51
21706	H. O. Wilbur & Sons., Inc., Philadelphia, *Wilbur-Dutch*[1]	8.53	5.58	0.09	3.51	3.95	18.35
	Cocoa Shells.						
436	Walter Baker & Co., Ltd., Dorchester, Mass[2]	9.43	7.76	2.57	2.81	14.83	3.04
	Sampled by Individuals.						
22896	Saville Chocolate Products Co., Pittsburgh, Pa., *Cho-Lay*	1.26	1.35	....	0.87	0.54	5.97
22233	Maltop Company, Buffalo, N. Y., *Chocolate Toddy*	3.32	2.86	....	2.00	0.76	5.73

[1] Dutch process.
[2] Starch 2.59, soluble carbohydrate 2.57

Diabetic, Special and Miscellaneous Foods.

In Table II are given analyses of diabetic, special and miscellaneous foods, eighty-two in number, which have been submitted by physicians, dietitians, patients, or others interested.

The conventional analysis of food shows the composition of the material in terms of several constituent groups, viz., moisture, ash, protein, fat and carbohydrate. Thus, ash represents the mineral elements, protein the nitrogenous materials, fat the true fats or oils and other substances removed by ether, and carbohydrate the starch, sugar and other nitrogen-free substances.

Protein is estimated from total nitrogen, generally by multiplying the nitrogen found by 6.25 on the assumption that protein contains 16 per cent. of nitrogen. But all proteins do not contain this exact amount and, in some cases, other factors are more accurate, e. g. 6.38 for casein protein and 5.7 for gluten. The kind of protein is not established nor is account taken of the fact that all of the nitrogen may not be in protein combination. Fats and oils are extracted by ether, and mineral oil, which is indigestible and which is used to a considerable extent in the manufacture of low-calorie products, will also be included in the ether extract. Crude fiber belongs to the carbohydrate group but it is not reckoned as an available nutrient in human digestion. The remainder of the carbohydrate group is not determined directly but calculated by subtracting from 100 per cent. the sum of all the other groups which have been determined.

As to how much of this carbohydrate group is available in digestion, that portion which is composed of starch, sugars and dextrin is digestible and can be determined by approved methods. In the table of analyses this portion is represented by the items "starch" and "soluble carbohydrate as dextrose". The remaining portion consists of hemicelluloses, gums, mucilages, etc., the availability of which must be regarded as neglible or doubtful.

There is an increasing use of materials of low nutritive value for the preparation of foods intended for low calorie diets. Cellu flour and cellulose flour from corn cobs are materials of this type which have been cited in previous reports of this Station[1]. Ecmo flour, Lister's Low Calorie Flour, and Nutrivoid Flour are new materials of this class which have been examined this year. These products contain but little nitrogen and fat and inconsiderable amounts of available carbohydrate. Cellu flour and the cellulose preparation from corn-cob showed about 60 per cent. of crude fiber while the analyses of the products examined this year show that the fiber content is low and that by far the greater part of the carbohydrate belongs to the undetermined nitrogen-free extract.

The French products distributed by the Hygienic Food Co.,

[1] Conn. Exp. Station. Bull. 227, p. 230; Bull. 255, pp. 172, 174.

excepting one preparation, **917** show from 40 to 80 per cent. of available carbohydrate.

Nut Flakes, **125**, is a product made from the same material of which Ecmo flour is made.

The starch content of Gluten Flakes **22216, 22278,** and **643** has been reduced to about 5 per cent. or less. Hoyt's Special Gluten Flakes and Protein Cereal contain 75 to 80 per cent. of protein with available carbohydrate of from 3 to 6 per cent.

Lister's Starch-free Bran, **22787,** shows more starch than this product generally contains and the second sample, **200**, supports the contention of the manufacturers on this point. Although the amount of starch present is of little practical significance, the manufacturers have voluntarily revised the label of the product to conform more closely to the facts as shown by analysis.

Diabetic Cereal **543**, Krinkles **21580**, and Malted Bran **22397,** are all satisfactorily low in carbohydrate.

Chocolate confections **919** and **920** contain about 30 per cent. of starch and sugar and should be eaten sparingly by the diabetic.

The canned fruits and vegetables examined are products prepared without sugar. Analyses represent the edible solids and liquor combined.

The miscellaneous products, excepting sardines packed in mineral oil, **675,** are normal foods examined as a matter of general dietetic interest.

The single analysis of green olives represents a composite of ten commercial samples and the analysis of ripe olives represents a composite of eight samples. The individual samples, particularly ripe olives, were examined for indications of spoilage, but none were detected.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS.

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Fat, Ether Extract
					N x 6.25	N x 5.7		Starch	Sugar as Dextrose	Other N-free Extract	
	Flours, Meals, etc.	%	%	%	%	%	%	%	%	%	%
	Curdolac Food Co., Waukeska, Wis.										
21581	Curdolac Flour...........................	4.98	7.78	6.58	41.13	....	6.53	0.84	3.76	22.54	12.44
	Jireh Diabetic Food Co., Morris Plains, N. J.										
22619	Soycasein Flour..........................	9.16	5.81	12.13	75.81	....	0.30	none	1.36	4.58	2.98
	Vitae Health Food Co., Seattle, Wash.										
179	Soya Manna.............................	8.88	4.35	6.58	41.13	....	1.50	none	10.68	14.45	19.01
	Efficiency Products Co., Somerville, N. J.										
124	Ecmo (Cellulose) Flour..................	9.05	1.00	0.66	4.13	....	4.75	none	3.44	77.00	0.63
	Lister Bros., Inc., New York City.										
22788	Lister's Low Calorie Flour................	7.55	6.10	0.63	3.94	....	5.24	none	1.76	74.84	0.57
	Nutrivoid Diabetic Flour Co., Brooklyn, N. Y.										
22779	Nutrivoid Flour..........................	8.23	1.17	0.69	4.31	....	7.18	none	6.08	72.11	0.92
	The Battle Creek Food Co., Battle Creek, Mich.										
22486	Cooked Bran............................	4.15	7.46	2.45	15.31	....	9.19		59.20		4.69

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Bakery Products, etc.	%	%	%	%	%	%	%	%	%	%
	H & R Diabetic Foods, Bronx, N. Y.										
2947	Bread of Low Food Value	24.80	3.43	1.51	9.45	....	9.37	0.99	0.75	27.92	23.29
2946	Bran Biscuit	11.47	4.04	1.06	6.62	....	6.26	1.24	0.92	56.95	12.50
905	Bran Biscuits, Spiced and Sweetened	4.80	3.81	1.22	7.63	....	7.60	1.52	0.68	55.57	18.39
904	Cellu Lemon Cookies	4.33	2.63	1.25	7.81	....	8.65	1.94	2.04	45.12	27.48
	Laboratoire E. Storage, Marseilles, France. (Hygienic Food Co., New York, Distributors)										
916	Madeleines Lucullus	5.20	1.13	1.40	8.75	....	0.38	31.58	15.32	14.21	23.43
917	Vichy Gaufrettes	3.35	2.37	2.36	14.75	....	2.33	7.54	5.84	12.89	50.93
918	Gaufrettes Vanillees	7.63	0.80	1.40	8.75	....	0.30	81.30		....	1.22
920	Nougatines de Vichy	2.15	2.23	1.60	10.00	....	1.20	3.60	37.40	15.07	28.35
	Therapeutic Foods Co. Inc., New York City.										
118	Aleurone Bread	9.89	3.16	10.88	....	62.02	0.27	13.42	2.03	7.54	1.67
119	Bread of Gluten	9.03	3.80	12.56	....	71.59	0.07	5.89	0.40	7.73	1.49
120	Special Diabetic Bread	9.44	2.86	11.06	....	63.04	0.14	14.05	0.96	8.43	1.08
123	Brusson Jeune Gluten Bread	10.01	0.72	6.89	....	39.27	0.14	9.00	3.83	36.04	0.99

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Breakfast Foods, etc.	%	%	%	%	%	%	%	%	%	%
	Efficiency Products Co., Somerville, N. J.										
25	Nut Flakes	9.56	1.04	0.70	4.38	....	5.61	none	2.78	75.59	1.04
	The Pure Gluten Food Co., New York City.										
116	Gluten Flakes	....	....	7.52	....	42.86	....	....	....	....	....
178	Gluten Flakes	5.04	3.78	7.77	....	44.29	5.93	2.87	9.96	22.05	5.18
343	Gluten Flakes	7.45	4.14	7.14	....	40.70	4.73	4.73	11.84	24.18	2.23
931	Hoyt's Protein Cereal	5.95	0.98	13.93	....	79.40	0.38	2.05	0.80	8.80	1.55
126	Hoyt's Special Gluten Flakes	8.64	1.01	13.00	....	74.10	0.31	5.24	0.67	8.09	1.94
	Gerda H. Wagner, Brooklyn, N. Y.										
543	Diabetic Cereal	7.45	4.47	1.61	10.06	....	13.28	....	1.35	58.82	4.57
	Lister Bros. Inc., New York City.										
300	Lister's Starch-free Bran	8.16	4.30	2.62	16.38	....	21.14	0.87	0.76	44.37	4.02
787	Lister's Starch-free Bran	5.65	5.72	2.80	17.50	....	18.88	2.87	2.86	40.97	5.55
	Curdolac Food Co., Waukesha, Wis.										
580	Krinkles	8.52	4.40	1.73	10.81	....	11.53	0.87	3.90	45.53	14.44

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Breakfast Foods, etc.—Continued.	%	%	%	%	%	%	%	%	%	%
	The Spa, Waukesha, Wis.										
897	Malted Bran	3.24	2.94	1.56	9.75	....	17.91	1.13	0.88	58.60	5.55
	H & R Diabetic Foods, Bronx, N. Y.										
903	Cellu Cocoa Nibs	3.80	2.79	1.32	8.25	....	8.00	2.11	2.12	42.83	30.10
	Confections, etc.										
	Frits, Vienna										
237	Plain Chocolate Bars and Cakes	3.22	2.90	2.41	15.06	....	1.77	4.61	2.36	15.28	54.80
238	Nut Chocolate	3.39	2.96	3.07	19.19	....	2.17	3.26	1.64	12.99	54.40
239	Ferment-Scho-Kolade	1.08	1.21	1.00	6.25	....	0.83	2.98	23.76	15.11	48.78
240	Saccharin-Schokolade	3.46	3.42	2.77	17.31	....	2.45	5.74	6.96	17.98	42.68
241	Dr. Fromm's Conglutin Schokolade	3.87	7.11	2.91	18.19	....	0.93	3.83	15.58	13.81	36.68
227	Cakes with Chocolate Icing	4.92	2.25	3.99	24.94	....	1.55	4.28	21.30	9.49	31.27
242	Peppermint Menthol Bonbons	10.04	1.76	0.32	....	....	....	trace	1.52	(1)	....
	Laboratoire E. Storage, Marseilles, France. (Hygienic Food Co., New York, Distributors)										
919	Pastilles de Chocolat	4.50	4.75	3.36	21.00	....	1.20	3.54	27.16	11.05	25.90
921	Croquettes de Chocolat Sucre	4.88	4.90	3.53	22.06	....	1.28	6.44	23.44	10.55	26.45

[1] Gums present.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued*.

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Fat, Ether Extract
					N x 6.25	N x 5.7		Starch	Sugar, as Dextrose	Other N-free Extract	
	Confections, etc.—Continued.	%	%	%	%	%	%	%	%	%	%
	The Genesee Pure Food Co., N. Y.										
22629	D-Zerta	25.40[1]	1.68	13.12	....	72.82[2]	....	0.00	0.00[3]	....	0.10
	Fruits and Vegetables. (Canned).										
	John Sexton & Co., Chicago, Ill.										
22427	Edelweiss Apricots	90.50	0.46	....	0.39	....	0.35	0.00	4.38	3.81	0.11
22428	Pride of the West Apricots	90.58	0.48	....	0.37	....	0.34	0.00	4.81	3.32	0.10
653	Alp Rose Blackberries	85.33	0.33	....	0.96	....	2.29	0.00	5.59	4.84	0.66
651	Alp Rose Blueberries	85.89	0.25	....	0.44	....	0.95	0.00	7.60	4.53	0.34
22431	Edelweiss Cherries	89.71	0.32	....	0.64	....	0.14	0.00	4.24	4.86	0.09
22432	Pride of the West Cherries	88.76	0.32	....	0.57	....	0.12	0.00	4.88	5.24	0.11
658	Alp Rose Royal Anne Cherries	86.18	0.36	....	0.63	....	0.15	0.00	7.58	5.05	0.05
650	Alp Rose Grapefruit	90.49	0.43	....	0.69	....	0.17	0.00	4.87	3.30	0.05
654	Alp Rose Logan Berries	85.43	0.34	....	1.04	....	1.82	0.00	5.60	5.09	0.68
22423	Edelweiss Peaches	91.73	0.31	....	0.37	....	0.26	0.00	4.04	3.24	0.05
22424	Pride of the West Peaches	91.72	0.31	....	0.38	....	0.24	0.00	4.76	2.55	0.04
656	Alp Rose Bartlett Pears	89.17	0.21	....	0.26	....	0.61	0.00	4.31	5.34	0.10
22425	Edelweiss Pears	90.35	0.23	....	0.24	....	0.56	0.00	3.70	4.82	0.10
22426	Pride of the West Pears	90.52	0.20	....	0.24	....	0.63	0.00	3.60	4.72	0.09
655	Alp Rose Pineapple, Hawaiian Sliced	85.81	0.35	....	0.36	....	0.27	0.00	8.49	4.61	0.11

[1] Includes undetermined organic acids.
[2] Calculated as gelatin, factor 5.55.
[3] Saccharin present.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Fruits and Vegetables. (Canned)—Cont'd.	%	%	%	%	%	%	%	%	%	%
	John Sexton & Co., Chicago, Ill.										
22429	Pride of the West Pineapple	86.17	0.30	....	0.38	....	0.28	0.00	9.65	3.17	0.05
657	Alp Rose Japan Plums	93.33	0.27	....	0.29	....	0.29	0.00	2.83	2.93	0.06
659	Alp Rose Prune Plums	88.63	0.33	....	0.33	....	0.21	0.00	6.92	3.50	0.08
22430	Pride of the West Prune Plums	88.88	0.30	....	0.39	....	0.21	0.00	4.83	5.27	0.12
652	Alp Rose Red Raspberries	89.02	0.31	....	0.67	....	1.69	0.00	4.81	3.00	0.50
648	Alp Rose Peeled White Asparagus	95.76	0.35	....	1.20	....	0.34	0.00	1.49	0.80	0.06
649	Alp Rose White Asparagus Tips	94.81	0.43	....	1.65	....	0.42	0.00	1.63	0.97	0.09
	The Poms Co., Sarasota, Fla.										
22433	Poms (Canned Grapefruit)	90.54	0.36	....	0.49	....	0.17	0.00	4.24	4.00	0.11
	Miscellaneous.										
	Bakery Products, etc.										
22893	Bread (Graham?)	40.00	....	....	8.89	....	....	....	....	....	1.19
22801	Rye Bread (Jewish)	4.57	2.90	2.17	13.56	....	0.31	63.56	7.42	6.28	1.40
22802	Heavy Dark Rye (Jewish)	4.19	3.84	1.99	12.44	....	1.00	57.77	6.36	12.73	1.67
22803	Medium Dark Rye (Jewish)	4.41	3.31	2.25	14.06	....	0.95	60.75	7.20	7.71	1.61
22800	Vienna Rolls (Jewish)	8.67	1.67	1.95	12.19	....	0.24	60.13	7.56	5.30	4.24
22799	Doughnuts (Jewish)	8.98	1.88	2.05	12.81	....	0.23	58.11	10.90	5.39	1.70
22894	Lister's Soup Powder	5.25	14.78	5.17	32.31	....	4.08	2.14	7.72	17.54	16.18

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Concluded*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Fat, Ether Extract
					N x 6.25	N x 5.7		Starch	Sugar, as Dextrose	Other N-Free Extract	
	Miscellaneous.	%	%	%	%	%	%	%	%	%	%
	Dairy Products.										
22741	Jewish Cottage Cheese	59.36	2.00	4.37	27.88[1]	....	....	....	....	1.61	9.15
22742	Jewish Sour Cream	51.48	0.49	0.64	4.08[1]	....	....	....	1.46[2]	0.88	41.61
	Fish.										
22743	Herring	56.84	7.12	2.99	18.71	....	....	....	....	....	17.33
22744	Salmon	64.21	10.88	3.44	21.51	....	....	....	....	....	3.21
675	Sardines (Canned in mineral oil)	58.50	5.40	3.65	22.80	....	....	....	....	....	13.30[3]
682	Turtle Meat, canned	75.01	0.94	3.74	23.37	....	....	0.00	0.00	0.00	0.68
	Fruits and Vegetables.										
22895	Carob Beans	4.13	2.67	1.00	6.25	....	5.66	0.00	80.67		0.62
401	Olives, green, edible portion[4]	76.33	6.58[5]	0.21	1.29	....	1.13	0.00	0.20	2.33	12.14
455	Olives, ripe, edible portion[6]	75.04	2.72[7]	0.22	1.38	....	0.88	0.00	0.25	1.74	17.99
22225	Quince, fresh, ripe, edible portion	84.14	0.43	0.05	0.30	....	1.80	0.37	4.20	8.82	0.14
22226	Quince, fresh, green, edible portion	84.71	0.47	0.08	0.49	....	1.88	0.47	4.32	7.48	0.18

[1] Factor N x 6.38.
[2] Lactose.
[3] About 80% mineral oil.
[4] Composite of 10 samples.
[5] Salt (NaCl) 5.88.
[6] Composite of 8 samples.
[7] Salt (NaCl) 2.11

Eggs.

Twelve samples of eggs were submitted by the Dairy and Food Commissioner for examination. All were sold as "fresh" eggs with various further qualifying terms. Four samples, (**29454, 30239, 30241, 30242**) were passed as fresh or reasonably fresh, and eight (**29875, 27901, 27866, 27865, 30237, 30238, 30240, 30243**), were classed as not fresh but edible.

The samples which were evidently fresh, or which were passed, had air spaces generally less than 1 inch in diameter, yolks not appreciably settled in the shell and ammoniacal nitrogen ranging from 0.8 to 1.2 mgms. per 100 grams of egg. Those which were classed as not fresh but edible, had air spaces larger than 1 inch, yolks settled in the shell, whites watery, and ammoniacal nitrogen varying from 1.9 to 3.7 mgms. per 100 grams of egg. Some of these having relatively low ammonia contents had probably been held at low temperatures.

Fats and Oils.

BUTTER.

Thirty samples of butter were submitted by the Dairy and Food Commissioner and one by the City Department of Health of New Haven. Twenty-two samples were sweet butter, nine of which were adulterated with water, the amounts ranging from 17.2 to 33.6 per cent. Nine samples were salt butter, of which four were found to be renovated and one to contain 22.6 per cent. of water and only 74 per cent. of fat. The other samples were not found adulterated.

Most of the sweet butter found to contain excess water was sold to various dealers under the representation that it was packed for the Farmington Creamery, a concern which has not been in existence for a number of years.

The adulterated samples are listed below:

No.	Material		Dealer	Manufacturer	Remarks
29955	Sweet butter	*Bridgeport*	Oak Hill Dairy	Own make	Excess water
28406	" "	*Meriden*	L. Zietz	Farmington Creamery	" "
28407	" "		Tomcuzk Bros.	" "	" "
28405	" "		C. & S. Market	" "	" "
28404	" "		L. Kosienski	" "	" "
28403	" "		M. Kosopsky	" "	" "
28400	" "		A. Goldberg	" "	" "
28627	" "	*NewHaven*	A. Gold	Own make	" "
28620	" "		E. Schoenberger & Sons	Farmington Creamery	" "
29956	Salt butter	*Bridgeport*	Oak Hill Dairy	Own make?	" "
27016	" "		L. Mattis	....	Renovated
27017	" "		A. Krufssik	....	"
27018	" "		E. Bergin	....	"
27019	" "	*Fairfield*	L. Bergin	....	"

Olive Oil.

Four samples of olive oil were examined for the Dairy and Food Commissioner. Two were passed and two were adulterated with cottonseed oil.

Adulterated samples were as follows:

D.C. No.	Brand		Dealer
30229	Pure Olive Oil, Lucca.	*Hartford.*	International Importing Co.
28588	B. B. Brand, Lucca.	*Waterbury.*	Frank Pepe.

Two samples were submitted by purchaser or distributor. One, **678,** Gilbert Brand bottled in France for John Gilbert & Son, New Haven, was genuine olive oil, but unusual in that it responded to the Villavecchia test for sesame oil. The test applied to the fatty acids however was negative.

Vanilla Extract.

Flavoring extracts for food purposes are solutions in ethyl alcohol of sapid and odorous vegetable principles.

Vanilla extract is the flavoring extract prepared from vanilla bean, with or without sugar or glycerin, and contains in one hundred cubic centimeters the soluble matters from not less than ten grams of the vanilla bean.[1]

No numerical limits of composition are included in the standard and these must be ascertained from analyses of authentic preparations derived from the several types of vanilla beans.

Twenty-seven samples of vanilla extracts or imitation vanilla extracts were collected by the Station agent, and one was submitted by the Dairy and Food Commissioner. Detailed analyses of these are given in Table III.

Most of the samples examined were labeled as pure or were presumed to be pure from the fact that no declaration to the contrary was made. A number were clearly stated to be imitations. The products presumed to be pure were found, in general, to conform to the limits of composition of pure extracts as established by analyses of authentic samples.[2] Three, Puritan **471,** Royal Scarlet **476,** and Champion **483,** showed excessive ash and other abnormal values which indicate the use of alkali in the process of manufacture.[3] Morrow **486,** although it contained a normal amount of vanillin and no coumarin, did not otherwise show the characteristics of a genuine vanilla extract. Nilla, **30404,** was sold simply as a flavoring extract but the name suggests vanilla while the analysis does not. Its composition closely resembles that of other imitation vanilla. Virginia Dare, **470,** is barely 150% strength assuming the minimum vanillin content of authentic vanilla extract.

[1] Circ. 136.
[2] See Winton, Albright and Berry, Jour. Ind. Eng. Chem., 7, 518, 1915.
[3] Dean and Schlotterbeck, Ibid. 8, 703, 1916.

TABLE III. ANALYSES OF

No.	Brand and Manufacturer	Precipitation with lead acetate		
		Amt. of ppt.	Color of ppt.	Color of fltr.
474	The Great A. & P. Tea Co., Jersey City, N. J., *Red Front*	Large	Buff	Straw
488	Austin Nichols & Co., N. Y., *Sunbeam*	Large	Buff	Straw
497	Baker Extract Co., Springfield, Mass., *Baker's* Pure Extract of Vanilla	Large	Buff	Straw
471	Boyce Extract Co., N. Y., *Puritan*	Large	Buff	Straw
487	The Bridgeport Public Market, Bridgeport, *Monogram*	Large	Buff	Straw
479	Joseph Burnett Co., Boston, Mass., *Burnett's*	Large	Buff	Straw
490	James Butler, Inc., N. Y., *Essie*	Large	Buff	Straw
464	The Cloverdale Co., Boston, Mass., *Benefit*	Large	Buff	Straw
498	J. W. Colton Co., Springfield, Mass., *Colton's Vanilla*	Large	Buff	Straw
483	Davey Bros., Inc., Bridgeport, *Champion*	Large	Buff	Straw
492	Andrew Davey, Inc., N. Y., *Atlas*	Large	Buff	Straw
470	Garrett & Co., Brooklyn, N. Y., *Virginia Dare*, 150% *strength*	Large	Buff	Straw
485	Howland's, Bridgeport, *Howco*	Large	Buff	Straw
491	McCormick & Co., Baltimore, Md., *Bee*	Large	Buff	Straw
472	The Mohican Co., N. Y., *Mohican*	Large	Buff	Straw
486	Morrow & Company, *Morrow's*	Small	Brown	Straw
478	The C. E. Sauer Co., Richmond, Va., *Sauer's Pure Concentrated*	Large	Buff	Straw
480	Schlotterbeck & Foss Co., Portland, Me., *Foss Pure Extract*	Large	Buff	Straw
484	Seeman Bros., Inc., N. Y., *White Rose*	Large	Buff	Straw
499	James Van Dyke Co., N. Y., *Ambassador*	Large	Buff	Straw
476	R. C. Williams & Co., N. Y., *Royal Scarlet*	Large	Buff	Straw
481	The Williams & Carleton Co., Hartford, *Williams* Pure Extract	Large	Buff	Straw
468	The Diamond Seal Product Co., Inc., N. Y., *Concord*, Vanillin, Coumarin and Vanilla	Small	Dk.Brown	Dk.Brown
30404[1]	Flagg & Co., Hartford, "*Nilla*" Flavoring Extract	Medium	Dk.Brown	Brown
496	Grand Union Tea Co., Brooklyn, N. Y., *Vanilla and Tonka*	Medium	Dark	Straw
466	The Stuart Brand, Hartford, *Imitation* Flavor of Vanilla	Small	Dk.Brown	Brown
494	The Stuart Brand, Hartford, *Imitation* Flavor of Vanilla	Small	Dk.Brown	Brown
493	Virginia Dare Extract Co., Brooklyn, N. Y., *Little Brown Jug, Imitation* Vanilla	Small	Dk.Brown	Brown

[1] Dairy Commissioner's Sample.

VANILLA EXTRACT, ETC.

Vanillin gm. per 100 cc	Coumarin gm. per 100 cc	Normal lead No.	Total solids, gms. per 100 cc.	Ash gms. per 100 cc			Alkalinity of ash, cc N/10 acid per 100 cc			Acidity, cc N/10 alkali per 100 cc			No.
				Total	Water-sol.	Water-insol.	Total	Water-sol.	Water-insol.	Of total extract	Due to vanillin	Other than vanillin	
0.16	None	0.68	14.96	0.35	0.28	0.07	41.0	25.0	16.0	38.0	10.4	27.6	**474**
0.16	None	0.54	18.88	0.31	0.25	0.05	39.0	29.0	10.0	34.0	10.3	23.7	**488**
0.20	None	0.71	15.43	0.36	0.27	0.09	43.0	28.0	15.0	40.0	13.0	27.0	**497**
0.15	None	0.53	8.92	0.69	0.53	0.15	71.0	36.0	35.0	32.0	9.7	22.3	**471**
0.18	None	0.70	16.84	0.35	0.24	0.11	45.0	26.0	19.0	41.5	11.6	29.9	**487**
0.21	None	0.53	9.63	0.31	0.23	0.08	42.7	24.7	18.0	42.0	14.0	28.0	**479**
0.16	None	0.58	20.26	0.32	0.21	0.11	32.5	20.5	12.0	31.5	10.3	21.2	**490**
0.16	None	0.58	12.67	0.25	0.18	0.07	36.0	21.0	15.0	31.5	10.7	20.8	**464**
0.18	None	0.75	15.43	0.37	0.28	0.10	47.0	29.0	18.0	42.5	12.2	30.3	**498**
0.12	None	0.47	8.63	0.67	0.53	0.14	74.0	41.5	32.5	29.0	8.2	20.8	**483**
0.15	None	0.51	20.44	0.30	0.23	0.07	36.5	23.0	13.5	30.0	9.6	20.4	**492**
0.16	None	0.48	15.83	0.29	0.23	0.05	33.5	23.5	10.0	36.0	10.4	25.6	**470**
0.19	None	0.71	8.32	0.36	0.28	0.08	42.0	26.5	15.5	38.0	11.5	26.5	**485**
0.19	None	0.69	8.48	0.40	0.32	0.09	47.5	32.0	15.5	37.0	12.4	24.6	**491**
0.19	None	0.60	15.66	0.30	0.24	0.06	40.5	27.5	13.0	40.0	12.5	27.5	**472**
0.20	None	0.19	15.63	0.08	0.05	0.03	13.5	9.0	4.5	26.0	13.1	12.9	**486**
0.24	None	0.60	20.55	0.30	0.22	0.08	40.5	27.5	13.0	41.5	15.5	26.0	**478**
0.13	None	0.47	13.78	0.25	0.17	0.09	28.7	17.0	11.7	33.0	8.5	24.5	**480**
0.12	None	0.60	20.64	0.41	0.29	0.12	42.0	27.5	14.5	40.0	8.1	31.9	**484**
0.11	None	0.70	15.71	0.41	0.33	0.08	47.5	31.5	16.0	27.5	5.4	22.1	**499**
0.14	None	0.51	8.94	0.67	0.51	0.16	67.5	34.0	33.5	32.0	9.4	22.6	**476**
0.11	None	0.54	13.75	0.36	0.29	0.07	20.0	9.5	10.5	30.0	7.0	23.0	**481**
0.20	0.06	0.06	17.64	0.03	0.01	0.01	3.0	1.0	2.0	.....	13.1	....	**468**
0.50	0.05	0.09	19.74	0.02	0.00	0.02	4.0	1.5	2.5	46.0	32.6	13.4	**30404**[1]
0.17	0.04	0.43	14.13	0.27	0.19	0.08	30.5	17.5	13.0	25.0	11.2	13.8	**496**
0.37	0.08	0.06	10.52	0.04	0.03	0.01	1.0	0.5	0.5	28.0	24.5	3.5	**466**
0.43	0.08	0.04	10.61	0.04	0.01	0.03	2.5	0.5	2.0	37.0	28.5	8.5	**494**
0.12	0.10	0.06	1.31	0.04	0.02	0.02	2.0	1.0	1.0	13.0	8.2	4.8	**493**

Flour, etc.

Twelve samples of "Graham" and "entire wheat" flours have been examined.

There seems to be no uniform opinion in the trade, or at least among retailers, as to the distinction between these two types of flour. Dr. Sylvester Graham, in his crusade against alcoholism, advocated rearrangement of diet as a remedy for this form of intemperance, and emphasized particularly abstinence from meat and the use of bread made from unbolted wheat meal. This unbolted wheat meal became known as "Graham" flour and such flour, evidently, should have the same composition as the wheat from which it is ground. The coarseness of the product, however, was thought by some students of nutrition at that time, to be an objection since it tended to cause the material to pass through the digestive tract before the nutrients had been sufficiently utilized. Attempts were made, therefore, to remove the coarse, outer (ovary) layers of the wheat berry and to grind the remainder without bolting, thus removing only the indigestible parts of the grain and retaining the entire nutritive value of the wheat. This flour was called "whole wheat flour" or "entire wheat flour."

The attempts to decorticate wheat for making entire wheat flour were, apparently, not very satisfactory, and the introduction of the roller process for milling flour probably discouraged further attempts to perfect methods. Probably many of the Graham and entire wheat flours of trade are recombinations of various fractions obtained in the process of commercial milling.

In Table IV are given analyses of flours sold as "Graham" and as "entire" or "whole" wheat. For comparison, analyses of wheat, of wheat bran and of red dog flour as quoted from Henry and Morrison[1] (protein being expressed on the basis of the factor 5.7), are given; and also analyses of recognized commercial grades of flour, viz., first patent, straight, and first clear as cited from a bulletin[2] of this laboratory.

On the basis of the protein-ash ratios some interesting comparisons can be made. It appears that the ratio is 6 for the whole wheat grain, although according to some analyses[3] it may slightly exceed 10; for bran it is about 2.5; and for the various grades of commercial flours it may be considered to range from 15 to 30, the values less than 20 being for low grade flours, and 20 or above, clear flours or better grades.

With this rough classification in mind, and remembering also that true Graham flour should have the same composition as the wheat from which it is made, and that in true entire wheat flour some of the bran is removed, it appears that, in general, the com-

[1] Feeds and Feeding, 17th edition.
[2] Conn. Exp. Sta. Bull. 255 (1923).
[3] Leech, Food Inspection and Analysis, p. 322.

mercial Graham flours do not exceed 10.0 and are nearer 6.0; and that there are no consistent differences between Graham and whole or entire wheat flours in this respect. Sample **22754** shows a ratio which indicates a low grade or clear flour rather than entire wheat flour; and the ratios in samples **22196** and **28776** indicate mixtures containing abnormal amounts of bran. It may be noted that the low grade flour known as red dog has a protein-ash ratio of nearly the same magnitude as the whole wheat grain; however, in the latter both protein and ash are conspicuously lower.

Three samples of semolina used in making macaroni were submitted by a purchaser and were examined for nitrogen. They contained from 12 to 12.7 per cent. of protein (on the basis of N x 5.7).

TABLE IV. ANALYSES OF "GRAHAM" FLOUR, ETC.

No.	Description of Sample	Moisture	Ash	Nitrogen	Protein (Nx5.7)	Fiber	Nitrogen-free extract	Fat	P/A
	Graham Flour.	%	%	%	%	%	%	%	
D.C.28776	F. A. Healey, Bridgeport. In bulk	11.09	2.40	2.42	13.79	2.36	67.22	3.14	5.7
D.C.28774	The Laramer Co., Willimantic. Choice Graham flour from entire wheat	11.14	1.98	2.30	13.11	2.48	68.45	2.84	6.6
D.C.28791	W. A. Maine, Norwich. In bulk	11.26	1.44	2.50	14.25	1.03	69.30	2.72	9.9
D.C.28794	J. A. Spinetta, New Britain	12.20	1.85	2.10	11.97	2.41	69.03	2.54	6.5
22194	Atlantic and Pacific Tea Co., New Haven, *Grandmother's*	9.53	2.09	2.43	13.85	1.68	70.59	2.26	6.6
22195	Grand Union Tea Co., New Haven, *Wheatsworth*	10.23	1.73	2.02	11.51	1.80	72.85	1.88	6.7
22764	Hartford Market Co., Hartford, *Pillsbury's*	10.02	1.87	2.27	12.94	2.28	70.34	2.55	6.9
22196	Quality Grocery, New Haven, *Schumacher, X X X*	9.23	2.69	1.71	9.75	2.66	72.22	3.45	3.6
	Whole Wheat or Entire Wheat Flour.								
D.C.28793	J. A. Spinetta, New Britain. Mill streams whole wheat stone ground flour	12.49	1.72	2.05	11.69	2.14	69.46	2.50	6.8
22756	E. E. Hall & Son, New Haven, *Purina*	9.95	1.45	2.30	13.11	1.31	72.38	1.80	9.0
22755	Frank S. Platt Co., New Haven	10.10	1.69	1.88	10.72	1.76	73.62	2.11	6.3
22754	Quality Grocery, New Haven, *Franklin*	10.30	0.81	2.10	11.97	0.28	74.86	1.78	14.8

TABLE IV. ANALYSES OF "GRAHAM" FLOUR, ETC.—*Concluded.*

No.	Description of Sample	Moisture	Ash	Nitrogen	Protein (Nx5.7)	Fiber	Nitrogen-free Extract	Fat	P/A
	Wheat Grain and Wheat Mill Products.	%	%	%	%	%	%	%	
	Wheat Grain[1]	10.20	1.90	1.98	11.29	2.20	.....	2.10	6.0
	Wheat Bran[2]	10.10	6.30	2.56	14.59	9.50	.....	4.40	2.3
	First Patent Flour[3]	9.70	0.38	2.00	11.40	....	.....	....	30.0
	Straight Flour[3]	10.00	0.48	2.10	11.74	....	.....	....	24.5
	First Clear Flour[3]	9.77	0.64	2.30	13.11	....	.....	....	20.5
	Red dog flour[4]	11.10	2.50	2.69	15.33	2.20	.....	4.10	6.1

[1] Based on 858 analyses.
[2] Based on 7742 analyses.
[3] Conn. Exp. Sta. Bull. 255. (1923.)
[4] Based on 259 analyses.

Gelatin.

A number of commercial gelatin products have been reported in previous bulletins.[1] Two samples, both submitted by a purchaser, have been examined during the past year.

644. Manufactured or distributed by James W. Dunn, Greenwich, N. Y.

645. Manufactured by the Atlantic Gelatin Co., Boston.

Partial analyses are as follows:

	644	645
Ash	1.53%	1.22%
Nitrogen	15.18	15.28
Gelatin (N x 5.55)	84.29	84.80
Fat	0.16	0.09
Keratin	0.06	0.03
Arsenic (parts per million)	none	0.5
Odor (hot water solution)	faint.	faint

State Regulation 52 relates to gelatin as follows:

Gelatin (edible gelatin) is the purified, dried, inodorous product of the hydrolysis, by treatment with boiling water, of certain tissues as skin, ligaments and bones, from sound animals, and contains not more than two per cent of ash and not less than 15 per cent. of nitrogen. It should not contain excessive amounts of metallic impurities. A hot water solution of gelatin should be clear and without offensive odor.

Pending further investigation, amounts of more than 1.4 parts of arsenic, 30 parts of copper and 100 parts of zinc in one million parts of gelatin will be regarded as excessive.

The samples examined were both passed as satisfactory.

Ice Cream.

Two hundred and sixty-nine official samples were submitted by the Dairy and Food Commissioner and three were submitted by manufacturers. Only five were found to contain less than 8 per cent of fat; one of these was sold under a sign or label which declared not less than 4 per cent. and was, therefore, within the provisions of the law, while another was but slightly under 8 per cent. and was passed. Three were deficient by substantial amounts as shown in the following summary:

Ice Cream Below Standard.

29311	Vanilla.	Derby	DeVarvieri and Musanti	7.1%
29301	Vanilla.	New Britain.	Chas. Piccoli	6.0
29184	Vanilla.	New Haven.	Huntington Confectionery Co.	6.9

The samples were secured from fifty-nine cities and towns in the State and may be classified on the basis of fat content as follows:

[1] Conn. Exp. Sta. Bull. 219. p, 221; 227, p 235; 255 p. 189.

	No. of samples.	Per cent. of total.	Per cent. for the 5-year period 1919-1923.
8.0- 9.9 per cent..	47	17.4	26.1
10.0-11.9 per cent..	67	24.8	23.2
12.0 and above.....	150	55.9	41.1
7.9 per cent. and below	5	1.9	9.6
Total.........	269	100.0	100.0

The summary shows that our 8 per cent. requirement is being very strictly complied with; that from 60 to 80 per cent. of samples examined contained 10 per cent. or more of fat; and that in over one-half, the fat content was 12 per cent. or over; and that, as compared with the preceeding five years, there is a considerable decrease in samples containing less than 10 per cent. of fat and an increase in those containing 12 per cent. or more.

Meat Products.

All the meat products examined were submitted by the Dairy and Food Commissioner to be tested for preservatives, excess or undeclared starchy material or undeclared color.

Table V. Hamburg Steak Containing Sulphites.

D. C. No.		Sampled at	Sulphur dioxide (SO_2), mgms. per kilo.
28217	*Bridgeport,*	Boston Public Market.......	382.0
28220		Helbig's Market	801.0
28221		Chicago Market............	113.0
28233		W. Auch..................	329.0
28224		Washington Public Market..	1016.0
28611	*Bristol,*	Valentines' Market.........	269.0
28612		The National Meat Market..	2323.0
28613		Public Market.............	2212.0
28614	*East Hartford,*	Aronson's Market..........	708.0
28437	*Naugatuck,*	Adolph Reiter..............	142.0
28438		The People's Market........	373.0
28426	*New Haven,*	The Congress Public Market.	1993.0
28234	*Norwalk,*	Fowler's Market............	171.0
28237	*Norwich,*	Wysod's Market............	346.0
28240		Grunville Public Market....	1794.0
28601		Self-Service Market.........	505.0
28609	*Plainville,*	V. G. Manello.............	640.0
28228	*Stamford,*	Saltzman's Market.........	4364.0
28227		Capitol Market............	274.0
28430	*Wallingford,*	Samuel Lev................	2312.0
28423	*Waterbury,*	Fulton Market.............	979.0
28441	*Willimantic,*	William Laramie...........	636.0

Hamburg Steak.

Sixty-two samples were examined and twenty-two were found to contain sulphites, the use of which is illegal under the general provisions of the food law and in violation of a specific State regulation.[1]

[1] Regulation 51.

Samples in which sulphites were found are given in Table V.

FRANKFURTS.

Thirty-four samples were submitted, fifteen of which contained undeclared, or excess of, starch or undeclared color. A summary of these samples is given in Table VI.

Two samples of casings were examined for color but none was found.

TABLE VI. FRANKFURTS CONTAINING EXCESS OF STARCH, OR ARTIFICIAL COLOR, OR BOTH.

D. C. No.	Dealer	Manufacturer	Remarks
	Bethel.		
28205	Bethel Provision Co.....	Own make........	Excess starch.
28206	Bethel Provision Co.....	Own make........	Excess starch.
	Bridgeport.		
29204	Thos. McNamara & Sons, Inc.	Own make........	Excess starch.
	Hartford.		
28062	Independent Packing Co.	....	Color undeclared.
28071	Eastern Provision Co...	Independent Packing Co.........	Starch and color undeclared.
28072	Grote & Weigel........	....	Color undeclared.
28073	Hartford Center Factory	....	Color undeclared.
	New Britain.		
28435	Adam Ostrowski.......	Own make........	Starch undeclared
	New Haven		
29205	Columbia Market......	T. J. McNamara & Sons, Bridgeport	Excess starch.
	Norwich.		
28238	Norwich Provision Co...	Own make........	Excess starch.
	Stamford.		
28409	Klein & Gmahle........	Own make........	Excess starch.
	Waterbury.		
28212	Kramer Bros...........	Sachenhauser,	Excess starch.
28422	Fulton Market.........	Own make........	Color undeclared.
28424	John Hullstrunk........	Own make........	Excess starch; color undeclared.
	Willimantic.		
28443	Liberty Cash Market...	Capitol Beef Co., Boston, Mass...	Starch undeclared.

Pork Sausage.

According to a State regulation, pork sausage may contain cereal or other starchy material provided it is declared upon the label or signs displayed and provided the amount does not exceed 2 per cent.

Fifteen samples of pork sausage were examined and none found in violation of these provisions.

Milk and Milk Products.

MARKET MILK.

Four hundred and seventy-three official samples of milk have been examined for the Dairy and Food Commissioner. This number is much smaller than for some years past due to the increased amount of testing done by licensed operators attached to the Commissioner's office. The tests required of the Station are thereby reduced to such as are necessary for checking purposes.

Two hundred and fifty-seven unofficial samples have been analyzed for the Commissioner; and also one hundred and sixty-eight for producers or consumers. The total from all sources is eight hundred and ninety-eight.

The four hundred and seventy-three official samples may be classified on the basis of the analyses, as follows:

	No. of samples	Per cent.
Not found adulterated	232	49.0
Adulterated by watering	26	5.5
Adulterated by skimming	23	4.9
Adulterated by reason of being sub-standard in solids and solids-not-fat	71	15.0
in solids and fat	9	1.9
in solids, fat and solids-not-fat	112	23.7
	473	100.00

Roughly, 50 per cent. were not found adulterated, 10 per cent. were watered or skimmed, and 40 per cent. were sub-standard in two or more of the items fat, solids, and non-fat solids.

Adulterated samples, other than sub-standard, are summarized in Table VII.

TABLE VII. ADULTERATED MILK.

No.	Dealer	Solids	Fat
	Containing Added Water		
	Cornwall Bridge.		
27344	Jacob Lorch........	10.39	2.8
	Glastonbury.		
28079	John Alekson.......	11.61	4.3
28080	John Alekson.......	12.03	4.5
	Litchfield.		
27776	B. O. Blakeslee.....	10.79	3.3
	Newtown.		
27817	Samuel Steinfelt....	9.90	3.0
27818	Samuel Steinfelt....	9.71	2.8
7819	Samuel Steinfelt....	10.39	3.2
	Niantic.		
7812	Harry Morton......	10.60	3.5
9281	J. H. Perkins.......	9.63	2.5
9284	Harry Morton......	10.34	3.2
9285	Harry Morton......	10.09	3.3
	No. Branford.		
9850	E. L. Cole.........	10.56	3.2
	Rockfall.		
7762	Joe Misiok.........	11.42	3.7
7763	Joe Misiok.........	11.69	4.0
	Containing Added Water—*Continued.*		
	Somers.		
27849	Max Levitt........	9.48	2.9
28100	Max Levitt........	9.30	3.0
	Thompsonville.		
29398	Thomas Bostick....	10.59	3.3
29399	Thomas Bostick....	10.54	3.3
	Torrington.		
28992	T. Semkman.......	11.42	4.1
	Watertown.		
28316	Tom Dubesky......	10.07	3.1
28317	Tom Dubesky......	10.22	3.1
28318	Tom Dubesky......	10.19	3.1
	West Cheshire.		
27773	Howard E. Ives.....	10.09	3.3
27775	Howard E. Ives.....	10.59	3.3
	West Cornwall.		
27347	Chester Turkowitz..	10.23	2.9
27800	Wm. Livingston....	10.60	3.1

EVAPORATED MILK AND SWEETENED EVAPORATED MILK.

Nine samples of evaporated milk and sweetened evaporated milk, six of which were submitted by the Dairy and Food Commissioner, have been examined and are summarized in Table VIII.

Evaporated milk should contain[1] not less than 7.8 per cent. of fat, 25.5 per cent. of solids and the sum of the percentages of fat and solids should be not less than 33.7.

Sweetened evaporated milk should contain[2] not less than 8 per cent. of fat and not less than 28 per cent. of milk solids. The sweetened products were examined for fat only.

[1] F. I. D. 189.
[2] Circ. 136.

TABLE VII. ADULTERATED MILK—*Concluded.*

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
	Skimmed Milk				**Skimmed Milk—** *Continued.*		
	Danbury.				*Norwich Town.*		
29777	Wm.MountianLunch	10.71	2.0	29643	Isadore Michon.....	11.15	2.5
29778	Depot Lunch.......	11.24	2.8	29646	H. R. Gardner......	9.78	1.8
29782	Groveland Lunch...	10.49	2.2				
	Hawleyville.				*Putnam.*		
28744	Alex Murin........	10.73	2.3	27409	Daniel J. Weeks....	11.21	2.7
				27412	John E. Tachariadis.	10.76	2.3
	Madison.			27413	Miller & Duffy.....	11.12	2.6
28715	New York Lunch...	10.57	2.1	27427	Miller & Duffy.....	10.63	2.0
	Mystic.				*Warehouse Point.*		
28703	Central Lunch......	9.15	0.7	29260	S. Wolcott Bissell...	12.06	3.0
28704	C. R. Worth.......	10.10	1.5				
					Westerly, R. I.		
	New London.			28701	White House Lunch.	11.26	2.5
28132	Crocker House Restaurant..........	11.29	2.8		*West Haven.*		
28133	Far East Restaurant.	9.93	1.4	27790	G. D. Shaw........	11.65	2.7
	Norwich.						
27433	James Hayes.......	10.30	2.0		*Willimantic.*		
27840	Fern's Restaurant...	11.51	2.6	27439	T. F. Shea.........	11.04	2.0
27846	Preston Pub. Market.	11.20	2.6	27445	A. Krug...........	9.76	1.4

TABLE VIII. ANALYSES OF EVAPORATED AND SWEETENED EVAPORATED MILK.

No.	Brand or Manufacturer	Fat	Solids	Fat + Solids
	EVAPORATED MILK.	%	%	%
646	Libby, McNeil and Libby........	8.22	26.65	34.87
647	" " " "	8.25	26.61	34.86
319	H. D. Lee Mercantile Co., *Lee*... Waterbury, Conn.............	7.82	26.29	34.11
D. C. 28078	Sheffield Condensed Milk Co., New York..................	7.94	25.87	33.81
D. C. 28077	Sheffield Condensed Milk Co., New York..................	7.91	25.85	33.76
D. C. 28245	The Borden Co., New York......	7.95	26.24	34.18
D. C. 28246	Rogers Milk Corp., New York *Freshpak.*	8.03	25.90	33.93
	SWEETENED EVAPORATED MILK.			
D. C. 28075	Sheffield Farm Milk Co., New York	8.23	.....	.....
D. C. 28076	" " " "	8.24	.....	.....

All of the evaporated milks met the requirements of the standard and the sweetened products conformed to the standard for fat.

CREAM.

Four samples of cream and sour cream were examined for fat. They were sampled by the Dairy and Food Commissioner and found to contain from 21 to 38.5 per cent. of fat. Samples were Nos. **28401, 17009, 29314** and **29151.**

CHOCOLATE-MILK.

One sample of this product was examined. It was sold by the Sagalou Farm, Branford.

Analysis:

Solids 16.0 per cent.; ash 0.76 per cent.; fat 3.21 per cent.; protein (factor 6.25) 3.06 per cent.; casein (approx.), 1.78 per cent.; sugar (by difference), 7.19 per cent.

BUTTERMILK[1]

Fermented milks are of two kinds viz., (1) that in which the fermentation produces only lactic acid and (2) those in which both lactic acid and alcohol are formed. Lactic acid is produced by the action of lactic-acid-forming bacteria while alcohol is formed by the action of certain types of yeasts although bacteria may be, in part, responsible.

Buttermilk is an example of the first named type of fermentation, *i. e.*, that in which lactic acid is the chief, or only, product of fermentation. As originally made, it was the sour milk left in the churn after the removal of butter. Now, however, commercial buttermilk is largely made from sour skimmed milk by inoculation with a "starter" (lactic acid bacteria), incubating at the proper temperature and finally breaking up the loppered milk by agitating until a uniform liquid or emulsion is obtained. Whole milk (*i.e.* unskimmed milk), may also be thus treated.

The second type of fermentation includes products containing both lactic acid and alcohol in varying proportions. Broadly there are two classes in this group viz., (a) where the acid predominates and (b) where the alcohol is the most conspicuous product. These two classes are determined by the kinds of yeasts or bacteria present and also by the temperature of incubation.

Yoghurt may be cited as an example of that class in which lactic acid predominates over the alcohol; and Kumiss made from mare's milk, and Kephir, the corresponding product made from cow's milk, are examples of products in which alcohol predominates.

In order to see whether fermented milks, as now found in trade, conform to the characteristics just stated for the several types,

[1] References consulted:
Heineman. Milk. 1921.
Rogers. U. S. Dept. Agr., Bureau Animal Industry. Circ. 171, 1911; Bull. 319, 1916.

three samples were secured in New Haven and two in Hartford All of these were of the buttermilk type and sold as such. No specially cultured milks of the Yoghurt or Kephir classes have been secured.

The five samples of buttermilk were examined as follows:

	21956	**21981**	**21980**	**27246** (Churned)	**27247**
Water.........	90.38%	83.01%	91.06%	93.41%	90.48%
Ash...........	0.88	0.72	0.76	0.57	0.76
Protein........	3.58	3.20	3.22	2.40	3.47
Fat...........	0.54	8.73	0.46	0.39	0.64
Sugar (calc.)...	4.62	4.34	4.50	3.23	4.65
Alcohol........	trace?	trace?	trace?	trace?	none?

All of these products except **21981** are made from skimmed milk.

As to alcohol our results obtained in the usual way, showed very inconsiderable amounts, the actual figures ranging from 0.03 to 0.10 per cent. Without further tests to positively identify alcohol, its presence may be questioned; however, one authority on this subject observes that while pure cultures of lactic acid bacteria produce only lactic acid, cultures in which other organisms may be present do produce small amounts of other related acids and sometimes *traces* of alcohol. At any rate, the statements made in the literature by authorities to the effect that the product generally known as buttermilk, contains no alcohol or not more than traces thereof, is substantiated by the analyses here given.

As to how much alcohol may occur in products of the second type of fermentation, Kumiss and Kephir may be cited. Recorded analyses show that Kumiss contains from 2.5 to 3.0 per cent. while Kephir contains from 0.6 to 0.75 per cent. No analyses of Yoghurt were found, but since it belongs to the class which is not conspicuous for alcohol it is reasonable to expect that it contains less of that constituent than Kumiss or Kephir.

HUMAN MILK.

Nineteen samples of breast milk, submitted chiefly by associations of Visiting Nurses and by physicians, have been examined. As in the case of cows' milk, wide variations occur in the compositions of different portions of milk of this type as noted in a previous bulletin.[1] The uncertainty of conclusions based upon analyses of samples which do not fairly represent the entire secretion is pointed out to those submitting samples of this kind.

Analyses of the samples submitted are given in Table IX.

[1] Conn. Exp. Sta. Bull. 227, p 255.

TABLE IX. ANALYSES OF HUMAN MILK.

No.	Solids	Protein (N. x 6.38)	Fat	Sugar	Ash
	%	%	%	%	%
21978	11.84	1.30	3.0	7.3	0.24
22245	11.84	1.36	3.4	6.84	0.24
22252	12.37	1.05	3.8	7.33	0.19
22253	11.63	1.45	2.8	7.07	0.31
22254	10.57	1.30	2.7	6.30	0.27
22346	15.53	1.58	6.4	7.28	0.27
22434	10.97	1.00	3.0	6.78	0.19
22616	11.28	1.00	2.8	7.22	0.26
22701	17.60	1.25	9.0	7.11	0.24
22853	16.76	1.13	8.8	6.63	0.20
22994	12.10	1.28	3.4	7.19	0.23
23179	13.14	1.23	4.8	6.89	0.22
23180	11.56	1.19	3.4	6.77	0.20
23181	13.52	1.87	4.6	6.81	0.24
23220	12.08	1.37	3.0	7.52	0.19
23369	12.47	1.40	3.8	7.03	0.24
23385	.....	....	5.4	....	....
914	11.95	1.03	3.4	7.41	0.11
274	.....	1.35	6.2	....	....

SPICES.

GROUND NUTMEG AND SAGE.

Nutmeg is the dried seed of *Myristica fragrans* Houtt., deprived of its testa, with or without a thin coating of lime (CaO). It contains not less than 25 per cent. of non-volatile ether extract, not more than 10 per cent. of crude fiber, not more than 5 per cent. of total ash, nor more than 0.5 per cent. of ash insoluble in hydrochloric acid.[1]

Sage is the dried leaf of *Salva officinalis* L. It contains not less than 1 per cent. of volatile ether extract, not more than 25 per cent of crude fiber, not more than 10 per cent. of total ash, nor more than 1 per cent. of ash insoluble in hydrochloric acid[2].

Eight samples of ground nutmeg and nine samples of sage were collected by the Station agent.

In all cases the requirements of the standard were fully met. Analyses are given in Table X.

[1] Circ. 136.
[2] *Ibid.*

TABLE X. ANALYSES OF NUTMEG AND SAGE.

No.	Brand or Manufacturer	Ether non-vol.	Extract vol.	Crude fiber	Total ash	Ash insol. in acid.
	NUTMEG.	%	%	%	%	%
410	Austin, Nichols & Co. Inc., N. Y. *Sunbeam*..........	32.41	....	3.04	4.10	0.09
428	Bennett, Simpson & Co.,N.Y	30.89	....	3.53	2.41	0.03
450	James Butler Inc., N. Y.....	34.50	....	2.85	1.98	0.05
405	Great Atlantic & Pacific Tea Co....................	35.99	....	2.55	3.09	0.07
453	Chas. G. Lincoln & Co., Inc. Hartford, *Capitol Mills*...	36.25	....	2.98	2.52	0.05
423	Grand Union Tea Co., Brooklyn...............	32.96	....	3.15	3.37	0.05
418	E. R. Durkee, Elmhurst,L.I.	37.53	....	2.38	2.02	0.02
447	Frances H. Leggett & Co., N. Y. *Premier*...........	35.89	....	2.83	2.58	0.03
	SAGE.					
427	Bennett,Simpson & Co., N.Y.	....	1.87	14.88	6.87	0.52
449	James Butler, N. Y. *Peerless*.	....	2.14	17.65	6.18	0.33
416	E. R. Durkee & Co., Elmhurst, L. I..............	....	1.88	16.68	6.11	0.22
402	E. R. Durkee & Co., Elmhurst, L. I..............	....	1.84	14.28	8.04	0.42
429	B. Fischer & Co. Inc., N. Y.	....	1.86	15.18	6.92	0.46
422	Grand Union Tea Co., Brooklyn...............	....	1.73	14.83	7.75	0.72
406	Great Atlantic & Pacific Tea Co....................	....	2.23	18.80	6.28	0.32
448	Frances H. Leggett & Co., *Premier*................	....	1.70	14.88	7.00	0.34
421	Williams & Carleton Co., Hartford...............	....	1.93	16.63	6.40	0.55

SYRUPS.

MAPLE SYRUP.

Six samples collected by inspectors of the Dairy and Food Commissioner's office were examined.

The product should contain not more than 35 per cent. of water and not more than 2.5 per cent. of ash[1].

All samples conformed to the standard, except **28765,** which contained an excess of water but otherwise appeared to be a genuine maple product. This sample had fermented slightly when examined.

Analyses are given in Table XI.

[1] Circ. 136.

TABLE XI. ANALYSES OF MAPLE SYRUP.

D. C. No.		Water %	Ash %	Lead No. %
28648	Great Atlantic & Pacific Tea Co......	32.20	0.55	1.32
28641	Rigney & Co., Brooklyn, *Colonial*...	34.05	0.52	1.22
28758	Seaman Bros., N. Y., *White Rose*....	33.36	0.50	1.26
28775	Welch Bros., Burlington, Vt., *Green Mountain Boy*..................	32.43	0.59	1.33
28755	*R. C. Williams & Co., N. Y., Royal Scarlet*.........................	32.76	0.59	1.29
28765	No label.........................	41.00	0.60	1.44

One sample **22945** submitted by a purchaser, was found to contain 33 per cent. of water and 0.66 per cent. of ash.

MOLASSES.

Twenty samples representing eleven brands were examined, all except two brands being analyzed in duplicate.

In all cases the limit of moisture set by the standard, viz., 25 per cent., is exceeded but the excesses are generally not greater than 10 per cent. of the standard. In two cases the ash exceeds the limit of 5 per cent., indicating a second or third molasses type. Sulphur dioxide was declared in all but two brands. One of these, **28773,** was declared to contain no sulphur dioxide and none was found; in **28645** and a duplicate, **30235,** no declaration of sulphur dioxide was made and only doubtful traces were found.

Analyses are given in Table XII.

HONEY.

An unofficial sample of strained honey, **28204,** submitted by the Dairy and Food Commissioner, was found to contain 20.58 per cent. of moisture (dried in vacuum at 60-65°C), 0.10 per cent. of ash and 1.55 per cent. of sucrose, and to be within the limits of composition for pure honey.

TEA[1].

Analyses of twelve samples of tea including well-known commercial brands and some typical grades are given in Table XIII. Description of the samples includes comments upon quality and cup characteristics as judged by expert tea tasters. Although quality and character of infusion cannot be interpreted in terms of exact chemical constituents this comparative data is, nevertheless, of considerable interest. These analyses also supplement work previously done[2] in this laboratory upon certain standard and market teas.

[1] Samples and data upon quality and cup characteristics were furnished through the courtesy of Mr. Ukers, editor of the Tea and Coffee Trade Journal, New York.

[2] Conn. Exp. Sta., Bull. 210, 1918.

TABLE XII. ANALYSES OF MOLASSES.

D. C. No.	Brand	Moisture %	Ash %
28760	*Amolco.* The American Molasses Co., New York	27.10	3.23
28762	*Belle Rose.* New Orleans Coffee Co., Ltd., New Orleans, La	26.70	2.39
29934	*Belle Rose.* New Orleans Coffee Co., Ltd., New Orleans, La	27.00	2.74
28784	*Brer Rabbit* (Gold label). Penick & Ford, New Orleans, La	26.00	4.05
29243	*Brer Rabbit* (Gold label). Penick & Ford, New Orleans, La	27.10	4.08
28785	*Brer Rabbit* (Green label). Penick & Ford, New Orleans, La	26.00	4.96
29242	*Brer Rabbit* (Green label). Penick & Ford, New Orleans, La	26.90	5.73
28790	*Cherry Grove.* Alexander Molasses Co., Chicago, Ill	25.20	7.24
29942	*Cherry Grove.* Alexander Molasses Co., Chicago, Ill	26.40	7.13
28644	*Dunbar's Old Fashioned.* Dunbar Molasses & Syrup Co., New Orleans, La	27.90	4.83
29904	*Dunbar's Old Fashioned.* Dunbar Molasses & Syrup Co., New Orleans, La	27.80	5.17
28645	*Dunbar's Pure Sugar House.* Dunbar Molasses & Syrup Co., New Orleans, La	27.30	2.89
30235	*Dunbar's Pure Sugar House.* Dunbar Molasses & Syrup Co., New Orleans, La	27.60	3.08
28759	*Giltedge.* W. Wirt Wickes & Son, New York	27.10	3.35
29241	*Giltedge.* W. Wirt Wickes & Son, New York	27.10	3.62
28773	*Grandma's.* Boston Molasses Co., Boston, Mass.	30.00	1.07
29943	*Grandma's.* Boston Molasses Co., Boston, Mass.	27.90	1.49
28751	*Moro.* The Southern Molasses Co., New York	25.09	7.47
29952	*Moro.* The Southern Molasses Co., New York	27.10	7.52
29244	*Rosemere.* The American Molasses Co., New York	26.00	3.92

TABLE XIII. ANALYSES OF TEA.

No.	Brand of Tea and Cup Characteristics	H_2O	Total Ash	Ash insol. in acid	Total Nitrogen	Fiber	Ether Extract	Hot Water Extract	Caffeine		Tannin
									Grav.	From N	
		%	%	%	%	%	%	%	%	%	%
76	*Typical Java*. Consists of Orange Pekoe and Pekoe leaf of good manufacture selected from a number of better known Java Tea Estates producing medium to fine qualities. Combines in leaf and liquor the grades of Java most favored in the United States and is thoroughly typical of the mass of good medium tea produced on that Island......	8.09	5.53	0.01	3.74	9.72	1.19	41.30	2.96	2.86	7.88
77	*Typical Black China*. Composite of North China teas of the better qualities used principally in the United States. Represents all characteristics of this class of black China tea. Lower grades of this type, as well as very choice teas used *only in small quantities*, have not been included in this composite sample........................	8.18	5.60	0.28	3.56	9.78	1.28	38.60	2.49	2.38	5.17
78	*Typical Ceylon*. Composed of medium and high grown teas from Ceylon Estates, Pekoe and Orange Pekoe leaf, and represents a typical Ceylon tea as regards flavor, strength and color of liquor....................	8.06	5.27	0.13	4.16	9.05	1.71	40.10	3.23	3.09	9.28
79	*Typical India*. Composite of Orange Pekoes and Pekoes produced in Darjeeling, Assam, Sylhet, Cachar and Dooars districts. Assam comprises *about 40 per cent. of the mixture*. Represents average North Indian production and exhibits qualities of strength, color and flavor of liquor characteristic of the growth of that seetion..................	8.24	5.83	0.19	4.02	10.08	1.51	39.20	3.44	3.33	7.97
45	*Saloda Orange Pekoe Blend*. Composed of Orange Pekoe leaf. Liquor flavory, light in color and bright. Cup character indicates										

No.	Brand of Tea and Cup Characteristics	H_2O	Total Ash	Ash insol. in acid	Total Nitrogen	Fiber	Ether Extract	Hot Water Extract	Caffeine Grav.	Caffeine From N.	Tannin
		%	%	%	%	%	%	%	%	%	%
46	*Lipton Yellow Label Orange Pekoe.* Described as "choicest blend of Ceylon and India tea of Orange Pekoe and other selected grades." A good medium tea with bright infusion and a liquor well balanced between Ceylon and India.	7.50	5.06	0.09	4.15	9.28	2.01	36.90	2.97	2.89	9.89
47	*Chase and Sanborn Orange Pekoe Blend.* Consists principally of Orange Pekoe leaf of very good quality. Predominating characteristic is of a high grown Ceylon with a touch of Darjeeling flavor. Liquor light and flavory.	7.52	4.97	0.03	4.10	9.40	2.31	41.10	2.83	2.77	8.93
48	*Tetley's Orange Pekoe.* Blend of Orange Pekoe and Pekoe leaf. Good medium quality and apparently consists chiefly of Ceylon and Java teas.	8.05	5.36	0.07	3.95	9.54	1.45	40.70	3.02	2.94	8.76
49	*White Rose Ceylon.* Straight Ceylon composed of Pekoes, medium and low grades. Liquor colory, of good strength with little flavor. A good household tea of medium quality.	8.19	5.14	0.04	4.17	9.72	1.91	39.60	3.49	3.30	8.67
50	*"Royal Garden" Orange Pekoe Ceylon-India.* The liquor indicates a blend of good medium quality, chiefly Ceylon and India with a trace of China flavor.	7.83	5.33	0.24	3.94	9.97	2.70	38.00	2.89	2.81	7.44
51	*"Thea-Nectar" Orange Pekoe.* Composed chiefly of Indian Orange Pekoe leaf. Liquor is of good strength and deep color. Flavor distinctly "Assamy".	8.23	5.68	0.10	3.97	10.32	1.36	38.80	3.47	3.31	7.71
74	*"Tree" Tea Formosa Oolong.* Straight Formosa of about "Superior" grade. A typical early summer medium fired Formosa of good quality.	8.66	5.78	0.54	3.66	11.16	2.56	40.50	2.90	2.74	11.38

Vinegar.

Thirty-nine samples were examined for the Dairy and Food Commissioner of which four were adulterated.

Three of the four adulterated samples were made by Silver and Kushmann, Waterbury, and one by J. A. Silver Bottling Works also in Waterbury.

Twenty-six samples have been submitted by individuals, representing mostly the product of farm manufacture.

Miscellaneous Foods, Etc.

The usual number of miscellaneous foods have been submitted by health officers, town officials or private individuals, either directly or through the office of the Dairy and Food Commissioner, to be examined for poisons or other injurious substances. The materials, forty-two in number, are listed as follows:

Table XIV. Foods Examined for Poisons, Etc.

No.	Name of Food	Remarks
961	*Baking Powder*	Available carbon dioxide 13.9 per cent. Required by standard 12 per cent.
681	Cakes	Copper, arsenic and lead found in quantity.
22231 **22232**	Cakes, bran	No evidence of poison found.
22344	Candy	No alkaloidal or metallic poisons found.
22343	Candy	No alkaloidal or metallic poisons found.
22592	Candy	No evidence of poison found.
22447	Candy	No volatile, alkaloidal or metallic poisons detected.
D.C.29465	Candy	No narcotic drugs found.
D.C.29986	Cider, sweet	Labeled 1-10 per cent. benzoate of soda. No alcohol was found and no injurious substance was detected.
22698	Cider	Alcohol 3.3 per cent; no heavy metals found.
22218	Cider	Dark color due evidently to oxidation of iron and combination with tannin absorbed from the barrel.
289	Cider	Alcohol 7.8 per cent.; had been preserved with "anti-ferment"
962 **963**	Coffee	No chicory, cereal products or other adulterants found.
D.C.29451	Macaroni Sauce	No evidence of spoilage.
D.C.27909	Malic acid	Used in making soft drinks. Showed characteristics of racemic malic acid.
22511 **22512**	Milk	Corrosive sublimate (mercuric chloride found.)
22191 **D.C.27249**	Milk, malted	Nothing found to suggest probable cause of illness. Rats fed on sample six days developed no unfavorable symptoms.

TABLE XIV—FOODS EXAMINED FOR POISONS, ETC.—*Concluded.*

No.	Name of Food	Remarks
22517	Mushrooms	Not positively identified. Appeared to be of edible type.
23083	Pickles	No alum or heavy metals found.
D.C.29452	Sardines	Unfit for food.
28117	Soda, cherry	No poisons detected.
22707	Vinegar	No poisons detected.
22628	Water	No poisons detected.
23022	Water, sugar, salt	No evidence of mercury or arsenic found.
22607	Water, medicinal	Not substantially different from ordinary drinking water.
21944	Wine, wild cherry (made without removal of pits)	Contained 4.7 mgms. hydrocyanic acid per 100cc.
22625	Wine, wild cherry (same as **21959**, 5 mos. later)	Contained 5.4 mgms. hydrocyanic acid per 100 cc.
21959	Wine, wild cherry (made after removal of pits)	Contained 1 mgm. hydrocyanic acid per 100 cc.

D. C. **27915** and **27908**, crown caps, D. C. No. **27907**, ginger ale were submitted to determine, if possible, the source of an oily taste in the ginger ale. Examination revealed no explanation of the off-taste about which complaint was made.

Arsenic was found in 5 cases of dog poisoning; and of two fowls examined, arsenic was found in one.

II. DRUGS.

The work on drugs for the past year includes the usual examinations of drugs recognized in the Pharmacopoeia and National Formulary, and of proprietary and miscellaneous products. In addition, a study has been made of variations in the amounts of medicament in pills and tablets, samples having been obtained chiefly from the stocks of dispensing physicians. A few preparations obtained on prescriptions have also been examined.

A classification of the products examined is as follows:

	No. of samples
Tablets and pills	92
Prescriptions	8
U. S. P. and N. F. drugs	25
Toilet preparations	18
Proprietary remedies, etc.	10
Miscellaneous	14
Total	167

Practically all of the samples in the three first named groups were submitted by the Dairy and Food Commissioner. Ninety-two samples of tablets and pills are reported here, but analyses of about forty more could not be completed for discussion in this report and will, therefore, be made a part of our work for the coming year. Such products present many analytical difficulties and the work consumes much time.

Tablets, Pills, Etc.

The ninety-two samples in this group represent one hundred and four items of medicament which were declared in definite quantities and which have been checked by direct determinations. In some instances constituents have been determined which were not declared as to quantity; and in other cases medicaments declared were not determined because of inadequate methods for reliable analyses.

The samples collected consisted of from twenty-five to one hundred tablets depending upon the nature of the medicaments and the analyses required. Individual weights of a representative number of tablets were taken, after which they were ground to a uniform powder, and the medicaments determined in percentage amounts of the ground sample. Maximum, minimum and average amounts of medicament were then calculated in terms of grains per tablet.

Weight Variations.

Variations in weights of tablets and pills are due, in part, to the mechanical limitations of manufacturing processes. Much improvement has been made in this direction in recent years and compressed tablets, at least, can be made with a surprising degree of uniformity. In the case of pills coated with saccharated lime, or similar preparations, the weight of the coating may considerably exceed that of the medicament enclosed and, hence, if it were possible or practicable to examine the medicament apart from the coatings, less variation might be shown than appears when calculations are based on analyses of the ground pills as a whole.

The complete data on weight variations for the samples examined are given in Table XV.

The distribution of samples on the basis of total variations in weight is shown in the following summary:

Variation from	No. of samples	Per cent. of total number
0 to 4.99 per cent	15	16.3
5 to 9.99 "	36	39.1
10 to 14.99 "	22	24.0
15 to 19.99 "	13	14.1
20 to 29.99 "	4	4.3
Over 30 "	2	2.2
Total	92	100.0

It is of interest to compare these results with similar data given in a previous report of this laboratory[1] which cites also the experience of Kebler. The results by Kebler were of about the same date as our earlier analyses; our recent results show a substantial improvement in this particular.

[1] Conn. Exp. Sta. Bull. 200, p. 188.

TABLE XV. VARIATIONS IN WEIGHT OF TABLETS.

No.	Drug and Manufacturer	Weight of tablet, mgms.			Total variation	
		Min.	Max.	Avg.	Mgms.	Per cent. of avg.
29960	Acetanilid Comp. (Acetasal) (Daggett & Miller)	316.0	346.0	335.0	30.0	9.0
29212	Acetanilid Comp. No. 1 (Direct Sales Co.)	358.0	423.5	397.3	65.5	16.5
29238	Acetanilid Tablets (DirectSales)	343.0	366.0	356.9	23.0	6.4
29209	Acetanilid Sodium Comp. (Maltbie Chem. Co.)	382.0	404.0	391.0	22.0	5.6
29962	Acetanilid Tablets (Salcelol) (Stoddard Co.)	338.0	364.0	353.0	26.0	7.4
29975	Acetanilid Tablets (Tilden Co.).	409.5	499.0	465.5	89.5	19.2
30208	Acetphenetidin (Direct Sales Co.)	403.0	432.0	416.0	29.0	7.0
29249	Acetphenetidin Tablets (Tailby-Nason)	408.0	446.5	430.0	38.5	9.0
30220	Acetphenetidin Tablets (Mfr?)	351.0	395.0	384.0	44.0	11.5
29959	Aspirin (Abbott Lab.)	400.5	425.0	411.5	24.5	6.0
29234	Aspirin (A. D. S.)	338.5	414.0	386.4	75.5	19.5
29929	Aspirin (A. D. S.)	371.0	432.0	399.7	61.0	15.3
29939	Aspirin (Bayer Co.)	378.5	423.0	401.7	44.5	11.1
29930	Aspirin (Brewer & Co.)	401.0	462.0	430.0	61.0	14.2
29240	Aspirin (Buffington, Inc.)	387.5	406.0	398.0	18.5	4.6
29938	Aspirin (De Pill Co.)	375.0	399.5	388.5	24.5	6.3
29237	Aspirin (Direct Sales Co.)	412.5	431.0	420.7	18.5	4.4
30207	Aspirin (Direct Sales Co.)	396.5	417.0	406.7	20.5	5.0
30217	Aspirin (Drug Products Co.)	387.0	423.0	401.6	36.0	9.0
29935	Aspirin (Fraser)	345.0	371.0	360.6	26.0	7.2
29906	Aspirin (Mfr?)	358.0	398.0	379.0	40.0	10.6
29941	Aspirin (Harvey Co.)	403.0	421.0	409.0	18.0	4.4
29950	Aspirin (Harvey Co.)	378.0	389.6	382.5	11.6	3.0
29940	Aspirin (Lee & Osgood)	380.5	423.0	399.0	42.5	10.7
29933	Aspirin (Lehn & Fink)	381.5	412.5	401.4	31.0	7.7
29944	Aspirin (Mulford Co.)	356.5	381.0	371.1	24.5	6.6
29218	Aspirin (National Drug Co.)	396.0	407.0	403.0	11.0	2.7
29239	Aspirin (National Drug Co.)	394.0	449.0	416.8	55.0	13.2
29928	Aspirin (Squibb)	354.0	378.5	362.8	24.5	6.8
29966	Aspirin (Surgeons and Physicians Supply Co.)	403.5	417.5	410.5	14.0	3.4
29210	Aspirin (Tailby-Nason)	353.0	384.0	365.4	31.0	8.5
29926	Aspirin (United Drug Co.)	359.0	405.0	380.0	46.0	12.1
30202	Aspirin (The Upjohn Co.)	460.0	493.0	471.3	33.0	7.0
29945	Aspirin (Wyeth)	356.0	390.0	380.0	34.0	8.9
29215	Aspirin (Yates D. & C. Co.)	383.5	435.5	421.4	52.0	12.3
29901	Aspirin (Yates D. & C. Co.)	387.0	466.0	431.1	79.0	18.3
29912	Aspirin (Yates D. & C. Co.)	443.0	470.5	459.0	27.5	6.0
940	Blaud's Iron Pills (United Drug Co.)	366.5	429.5	397.0	63.0	15.9
30206	Calcium, Iodized (Direct Sales Co.)	64.5	80.1	74.5	15.6	20.9
29229	Calcium Sulphide Pills (Upjohn Co.)	136.0	152.0	143.0	16.0	11.2
29230	Calcidin (Abbott Laby.)	124.3	139.9	130.9	15.6	11.9

TABLE XV. VARIATIONS IN WEIGHT OF TABLETS—*Continued.*

No.	Drug and Manufacturer	Weight of tablet, mgms.			Total variation	
		Min.	Max.	Avg.	Mgms.	Per cent. of avg.
29222 30223	Calomel (Yates D. & C. Co.)	90.0	96.0	92.3	6.0	6.5
29991	Calomel (Mfr?)	114.0	126.5	121.0	12.5	10.3
29919	Corrosive Sublimate (Davis, Rose Co.)	978.0	1009.0	991.1	31.0	3.1
30227	Corrosive Sublimate (Davis, Rose Co.)	921.5	1011.0	964.4	89.5	9.3
30228	Corrosive Sublimate (Morgenstern & Co.)	925.0	1045.0	993.0	120.0	12.1
29219	Coryza No. 2 (G. S. Stoddard & Co.)	157.2	187.3	176.9	30.1	17.0
30209	Hexamethylenamine (Direct Sales Co.)	317.0	331.0	323.6	14.0	4.3
29226	Hexamethylenetetramine (Buffington, Inc.)	312.5	324.0	322.4	11.5	3.6
30212	Hex-Iodine Lozenges (Daggett & Miller)	950.9	980.3	965.5	29.4	3.0
29908	Hydrastin - Strychnine Trit. (Smith Pharmacal Co.)	75.3	89.4	80.9	14.1	17.4
29228	Migraine Tablets (Nat. Drug Co.)	414.0	469.5	435.5	55.5	12.7
29225	Migraine Tablets (Tailby-Nason)	220.0	236.5	226.0	16.5	7.3
29932	Morphine Sulphate (Hypoderm.) (John Weyth & Bros.)	15.5	18.0	16.6	2.5	15.1
29247	Nitroglycerine Tablets (Nat. Drug. Co.)	34.9	40.0	37.5	5.1	13.6
29213	Phenolphthalein Tablets (Direct Sales Co.)	148.0	168.5	162.9	20.5	12.6
29915	Quinine Sulphate (Harvey Co.)	230.0	270.5	253.5	40.5	16.0
29924	Quinine Sulphate (Standard Laby.)	245.5	261.0	253.2	15.5	6.1
29246	Quinine Sulphate (Nat. Drug Co.)	288.0	307.0	299.0	19.0	6.4
30203	Quinine Sulphate (Yates D. & C. Co.)	319.0	368.0	350.0	49.0	14.0
29910	Sedative Pills No. 3 (G. F. Harvey Co.)	390.8	499.3	432.0	108.5	25.1
29953	Sodium Bromide (A. D. S.)	370.0	412.0	392.5	42.0	10.7
29978	Sodium Bromide (Tailby-Nason)	640.0	658.0	650.0	18.0	2.8
29236	Triple Bromides (Tailby-Nason)	495.5	516.5	506.2	21.0	4.1
29961	Sodium Salicylate (Daggett & Miller)	507.0	531.0	518.0	24.0	4.6
30214	Sodium Salicylate (Daggett & Miller)	397.0	419.0	406.7	22.0	5.4
29214	Sodium Salicylate (Direct Sales Co.)	416.0	448.5	436.0	32.5	7.5
29221	Sodium Salicylate (Direct Sales Co.)	437.5	470.0	454.2	32.5	7.2
29951	Sodium Salicylate (Harvey Co.)	320.0	413.0	373.3	93.0	24.9

TABLE XV. VARIATIONS IN WEIGHT OF TABLETS—*Concluded.*

No.	Drug and Manufacturer	Weight of tablet, mgms.			Total variation	
		Min.	Max.	Avg.	Mgms.	Per cent. of avg.
29208	Sodium Salicylate (Rheumatic Tablets) (Maltbie Chem. Co.)	798.0	831.5	813.6	33.5	4.1
29931	Sodium Salicylate (Haberle Drug Co.)................	388.0	430.0	416.6	42.0	10.1
29923	Sodium Salicylate (Standard Laby.)..................	454.0	519.5	485.8	65.5	13.5
29920	Sodium Salicylate (Strasenburg Co.)..................	433.0	464.5	452.7	31.5	7.0
29248	Sodium Salicylate (Syracuse Pharmacal Co.)...........	381.0	404.0	392.1	23.0	5.9
29248D	Duplicate of 29248 (Syracuse Pharmacal Co.)...........	380.0	398.0	390.0	18.0	4.6
29235	Sodium Salicylate Comp. (Tailby-Nason)............	398.5	434.0	414.0	35.5	8.6
29903	Sodium Salicylate (Tailby-Nason.).................	385.0	425.5	412.7	40.5	9.8
29967	Sodium Salicylate (Tailby-Nason).................	366.0	390.0	381.3	24.0	6.3
29946	Sodium Salicylate (Yates D. & C. Co.)..................	449.0	485.5	463.1	36.5	7.9
30211	Sodium Salicylate (Yates D. & C. Co.)..................	434.5	486.5	455.3	52.0	11.4
29914	Strontium Salicylate (Daggett & Miller).................	500.0	535.0	509.0	35.0	6.9
29905	Strontium Salicylate (Tailby-Nason)..................	425.0	457.0	441.0	32.0	7.3
29969	Strychnine Sulphate (A. D. S.).	165.0	188.0	178.1	23.0	12.9
29216	Strychnine Sulphate (Daggett & Miller Co.).............	103.0	117.0	108.3	14.0	12.9
29216D	Duplicate of 29216 (Daggett & Miller Co.).............	103.5	114.5	111.0	11.0	9.9
29900	Strychnine Sulphate (Glen Pharmacal Co.)...........	73.0	85.5	78.7	12.5	15.9
30219	Strychnine Sulphate (The Harvey Co.).................	32.0	38.0	34.6	6.0	17.3
29211	Strychnine Sulphate (Nat. Drug Co.)......................	73.0	88.0	82.2	15.0	18.2
30210	Strychnine Sulphate (Yates D. & C. Co.)...............	40.0	49.5	43.0	9.5	22.1
29916	Thyroid (Desiccated) Tablets (Harvey Co.)..............	396.5	547.5	496.2	151.0	30.4
29989	Thyroid (Desiccated) Tablets (Harvey Co.)..............	366.0	512.0	409.2	146.0	35.7
29911	Valerian Compound (Tailby-Nason)...................	428.3	460.4	446.1	32.1	7.2

Variation of	Per cent. of samples examined by Kebler	Connecticut 1917	Connecticut 1924
Less than 10 per cent..........	43	44	55
More than 10 " "	57	56	45
More than 15 " "	28	26	21
More than 20 " "	9	10	7

VARIATIONS IN MEDICAMENT.

In addition to variations in medicament caused by the limitations of weight control, other factors enter into consideration, such as the purity of the basic drugs used, the mixing of them, and finally the limits of reasonable error in analysis. The manufacturer must be presumed to have determined that the drugs he uses conform to the limits of purity prescribed by the U. S. Pharmacopoeia or National Formulary, or, in case of drugs not recognized therein, to a degree of purity established by reliable analyses, and to have based the claims for his finished product accordingly. Approved analytical methods[1] are available for many of the medicaments ordinarily encountered in products of this type; but conclusions must be drawn cautiously in case of methods, the limitations of which are not sufficiently established.

Table XVI gives maximum and average variations in medicament in terms of grains per tablet and in percentages referred, in both cases, to the quantities of drugs declared to be present. A study of the tabulation shows that the maximum variation from the dosage claimed has been a shortage in sixty-one items and an overage in forty items; in other words the —and +variations have been about 6:4. In more than one-half of the items determined, the variation in dosage between the lightest and heaviest tablets or pills was within 10 per cent. of the dosage declared; in over three-fourths of the items this range was less than 15 per cent.; and in nearly seven-eighths of the items the range did not exceed 20 per cent.

If the average variation from claimed dosage is considered, the comparison is, naturally, somewhat better. Thus we find that the average variation from the stated dose is less than 10 per cent. in about four-fifths (79.8 per cent.), of the items determined; in about two-thirds (65.4 per cent.) of the items the variation does not exceed 5 per cent.

These conclusions are best shown in tabular form as follows:

Variations from	Maximum variation		Average variation	
	Items determined	Per cent.	Items determined	Per cent.
0 to 4.99 per cent.	24	23.8	68	65.4
5 to 9.99 " "	31	30.7	15	14.4
10 to 14.99 " "	24	23.7	8	7.7
15 to 19.99 " "	8	7.9	5	4.8
20 to 29.99 " "	11	10.9	6	5.8
30 upward " "	3*	3.0	2*	1.9
Totals	101	100.0	104	100.0

*Includes one item (in **29960**) which is obviously a mistake in labelling.

Again we may refer to a similar summary[2] revised to a basis

[1] Methods of the A. O. A. C. and of the U. S. Pharmacopoeia have been followed wherever possible.

[2] Conn. Exp. Sta. Bull. 200 (1917).

comparable with the above tabulation. The comparison as regards maximum variation from claim is as follows:

Variations from	1917 Items determined	1917 Per cent.	1924 Items determined	1924 Per cent.
0 to 4.99 per cent...........	25	16.2	24	23.8
5 to 9.99 " "	45	29.2	31	30.7
10 to 14.99 " "	41	26.6	24	23.7
15 to 19.99 " "	21	13.6	8	7.9
20 to 29.99 " "	10	6.5	11	10.9
30 upward, " "	12	7.9	3	3.0
Totals.................	154	100.0	101	100.0

Since an improvement has been shown in the matter of uniformity of weight of tablets as compared with our previous inspection, less variation in medicament would, therefore, be anticipated at this time. The above comparison shows that such is the case. About 55 per cent. of the determinations made were within 10 per cent. of the quantity of drug declared as compared with 45 per cent. showing a like range in 1917. Twenty-two per cent. of the individual items determined varied from the stated dose by 15 per cent. or more while the corresponding figures in our previous inspection is twenty-eight per cent. The improvement in uniformity of medicament parallels rather closely the increase in uniformity of tablet weights.

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.

No.	Drug	Claim, grains	Maximum variation, grains	Maximum variation, per cent.	Average variation, grains	Average variation, per cent.
29960	Acetanilid.........	2.6	−0.4	−15.4	−0.2	−7.7
29975		5.0	+0.6	+12.0	+0.2	+4.0
29238		5.0	−0.4	−8.0	−0.2	−4.0
29209		2.5	±0.1	±4.0	±0.0	±0.0
29212		2.0	−0.3	−15.0	−0.1	−5.0
29962		2.5	±0.1	±4.0	±0.0	±0.0
29228		2.5	−0.4	−16.0	−0.3	−12.0
29225		2.0	+0.1	+5.0	±0.0	±0.0
29235		2.5	±0.1	±4.0	±0.0	±0.0
29249	Acetphenetidin.....	5.0	±0.2	±4.0	±0.0	±0.0
30208		5.0	+0.6	+12.0	+0.3	+6.0
30220		5.0	−0.6	−12.0	−0.2	−4.0
29941	Aspirin............	5.0	+0.3	+6.0	+0.1	+2.0
29950		5.0	+0.2	+4.0	+0.1	+2.0
29944		5.0	−0.3	−6.0	−0.1	−2.0
29940		5.0	+0.3	+6.0	±0.0	±0.0
29938		5.0	−0.3	−6.0	−0.1	−2.0
29939		5.0	−0.3	−6.0	±0.0	±0.0
29935		5.0	−0.7	−14.0	−0.5	−10.0
29933		5.0	+0.3	+6.0	+0.1	+2.0
29930		5.0	−0.4	−8.0	±0.0	±0.0
29929		5.0	+0.7	−14.0	+0.2	+4.0
29234		5.0	−0.7	−14.0	−0.1	−2.0
29928		5.0	−0.3	−6.0	−0.2	−4.0
29926		5.0	−0.6	−12.0	−0.3	−6.0

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.—*Continued*

No.	Drug	Claim grains	Maximum variation grains	Maximum variation per cent.	Average variation grains	Average variation per cent.
29945	Aspirin............	5.0	−0.3	−6.0	±0.0	±0.0
29959		5.0	−0.4	−8.0	−0.3	−6.0
29901		5.0	+0.7	+14.0	+0.3	+6.0
29912		5.0	−0.2	−4.0	±0.0	±0.0
29215		5.0	−0.4	−8.0	±0.0	±0.0
29906		5.0	−0.5	−10.0	−0.3	−6.0
29210		5.0	+0.3	+6.0	+0.1	+2.0
29218		5.0	−0.2	−4.0	−0.1	−2.0
29239		5.0	+0.6	+12.0	+0.2	+4.0
29237		5.0	±0.1	±2.0	±0.0	±0.0
29240		5.0	−0.2	−4.0	−0.1	−2.0
30207		5.0	±0.1	±2.0	±0.0	±0.0
30202		5.0	−0.3	−6.0	−0.2	−4.0
29966		5.0	−0.2	−4.0	−0.1	−2.0
30217		*5.0*	*+0.4*	*+8.0*	*+0.1*	*+2.0*
29911	Barbital...........	0.25	......	......	−0.01	−4.0
940	Blaud's Pills (Ferrous Sulphate)	1.0	+0.2	+20.0	+0.1	+10.0
29236	Bromide, Ammonium	2.5	+0.1	+4.0	±0.0	±0.0
29236	Bromide, Potassium.	2.5	+0.3	+12.0	+0.2	+8.0
29219		0.167	......	......	−0.006	−3.6
29978	Bromide, Sodium....	10.0	−0.4	−4.0	−0.2	−2.0
29953		5.0	±0.3	±6.0	±0.0	±0.0
29236		2.5	−0.1	−4.0	±0.0	±0.0
29209	Caffeine...........	0.5	±0.0	±0.0	±0.0	±0.0
29228		0.25	−0.02	−8.0	−0.01	−4.0
29225		0.25	±0.01	±4.0	±0.00	±0.0
29235		0.25	−0.02	−8.0	−0.01	−4.0
29960	Caffeine citrate.....	0.13	+0.12	+92.3	+0.11	+84.6
29212		0.50	±0.00	±0.0	±0.00	±0.0
29230	Calcidin...........	0.15	+0.05	+33.3	+0.03	+20.0
29229	Calcium sulphide...	1.0	−0.1	−10.0	±0.0	±0.0
29222	Calomel (Mercurous	0.10	+0.02	+20.0	+0.01	+10.0
30223	chloride)....					
29991		0.25	+0.02	+8.0	+0.01	+4.0
29219	Camphor..........	0.25	......	......	−0.05	−20.0
29212	Camphor Monobromate	0.5	+0.1	+20.0	±0.0	±0.0
29225		0.5	±0.0	±0.0	±0.0	±0.0
30228	Corrosive Sublimate (Mercuric chloride)	7.3	+0.7	+9.6	+0.3	+4.1
30227		6.9	+0.4	+5.8	±0.0	±0.0
29919		6.9	+0.8	+12.0	+0.6	+8.8
29226	Hexamethylenetetramine..........	5.0	−0.2	−4.0	−0.1	−2.0
30209	"	5.0	−0.2	−4.0	−0.1	−2.0
29228	Morphine Sulphate..	0.05	±0.00	±0.00	±0.00	±0.0
29932		0.125	+0.015	+12.00	+0.005	+4.0
29247	Nitroglycerine......	0.01	±0.0	±0.0	±0.0	±0.0
29213	Phenolphthalein....	2.0	+0.3	+15.0	+0.2	+10.0
29915	Quinine Sulphate...	2.0	+0.2	+10.0	+0.1	+5.0
29924		2.0	−0.2	−10.0	−0.1	−5.0
29246		2.0	−0.3	−15.0	−0.2	−10.0
30203		2.0	+0.3	+15.0	+0.2	+10.0
29209	Sodium Bicarbonate.	2.5	−0.4	−16.0	−0.4	−16.0
29228		1.0	+0.1	+10.0	+0.0	+0.0

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.—*Concluded*

No.	Drug	Claim grains	Maximum variation. grains	Maximum variation. per cent.	Average variation. grains	Average variation. per cent.
29208	Sodium Bicarbonate.	2.5	+0.1	+4.0	±0.0	±0.0
29235		1.0	−0.1	−10.0	±0.0	±0.0
29228	Sodium Salicylate...	1.75	−0.34	−19.4	−0.27	−15.4
29967		5.0	−0.4	−8.0	−0.3	−6.0
29903		5.0	−0.5	−10.0	−0.2	−4.0
29214		5.0	−0.4	−8.0	−0.2	−4.0
29221		5.0	+0.2	+4.0	+0.1	+2.0
29920		5.0	−0.3	−6.0	−0.1	−2.0
29923		5.0	−0.6	−12.0	−0.2	−4.0
29931		5.0	+0.3	+6.0	+0.2	+4.0
29946		5.0	−0.3	−6.0	−0.2	−4.0
29951		5.0	−1.0	−20.0	−0.3	−6.0
29961		5.0	±0.1	±2.0	±0.0	±0.0
29235		1.75	+0.17	+9.7	+0.08	+4.6
29208		7.5	−0.3	−4.0	−0.1	−1.3
30214		5.0	−1.4	−28.0	−1.3	−26.0
29248		5.0	−1.2	−24.0	−1.1	−22.0
29248D		5.0	−1.2	−24.0	−1.1	−22.0
30211		5.0	+0.5	+10.00	+0.2	+4.0
29914	Strontium Salicylate.	5.0	−0.5	−10.0	−0.4	−8.0
29906		5.0	±0.2	±4.0	±0.0	±0.0
29211	Strychnine Sulphate.	0.033	+0.007	+21.0	+0.005	+15.1
29969		0.033	+0.004	+12.0	+0.002	+6.0
29900		0.017	+0.004	+23.5	+0.003	+17.6
29216		0.017	+0.008	+47.1	+0.006	+35.3
29216D		0.017	+0.005	+29.4	+0.005	+29.4
30210		0.033	+0.006	+18.2	+0.001	+3.0
30219		0.017	−0.004	−23.5	−0.003	−17.6

COMMENTS ON ANALYSES.

Table XVII gives the analytical data obtained upon the tablets and pills examined, ninety-two in number. In general, the plan adopted for judging the products was to designate as "satisfactory" the tablets or pills in which the average quantity of medicament equaled the quantity claimed, and in which the variation in medicament, as calculated for the lightest and heaviest units, did not exceed 10 per cent. of the claimed dose. Tablets or pills in which the average quantity of medicament was found to be within 10 per cent. of the quantity claimed were "passed." In a few instances where the quantity of medicament was very small, or where it could not be determined with the exactness desired, the latter designation was used with somewhat more tolerance. This plan is not ideal, but it is based upon the belief that some distinction should be made between those products which show a conspicuous degree of uniformity and those which do not, and, furthermore, that the average dose should equal the declared dose, and that variations should be + and — in about equal magnitude. It is recognized that a tolerance which may be perfectly fair as applied to aspirin tablets, for example, may be very irrational when applied to hypodermic tablets. This is a subject

which needs further consideration. The kind and amount of drug involved and the effects likely to result from an overdose must be taken into account in determining the magnitude of reasonable tolerances.

Particular comment is due with respect to a number of analyses listed in Table XVII. **29960.** *Acetasal.* This product shows about twice the quantity of caffeine citrate indicated by the label; in other words, our results show about 2.5 per cent. caffeine instead of 2.5 per cent. caffeine citrate. This is evidently an error in labelling. In our previous inspection a product of similar name and made by the same manufacturer was declared to contain 2.5 per cent. caffeine.

29228. *Migraine Tablets No.* 8. The deficiency in sodium salicylate exceeded 10 per cent. but other ingredients were substantially correct and the tablets were passed.

29209. *Acetanilid Sodium Compound.* This was correct in the main ingredients and the deficiency in sodium bicarbonate was passed.

29248 and **29248 D.** *Sodium Salicylate.* These samples were low in sodium salicylate but both were from the same stock. No other sample of this manufacturer was found among the physicians visited.

29216 and **29216 D.** *Strychnine sulphate.* Both these samples contained excesses of medicament but both were from the same source. No other samples of strychnine sulphate of this make were found among the physicians visited.

To summarize, it may be said that of 92 samples, representing thirty-three manufacturers (2 samples were of unknown make), 29 were satisfactory and 57 were passed. Six varied from claim by considerable amounts. These were Acetasal, **29960** (with the comment noted), sodium salicylate, **30214,** strychnine sulphate, **29216** and **29216 D,** and sodium salicylate, **29248** and **29248 D.**

Prescriptions.

ARSENOUS ACID.

29965. Sample of arsenous acid, bought on prescription, H. F. Ruby and Co., Hartford. Required not less than 0.975 per cent. of arsenous oxide, As_2O_3; found 0.46 per cent. A second sample from the same source showed 0.41 per cent. Both samples were less than ½ strength.

30233. Sample obtained on prescription calling for solution of arsenous acid, Victor W. Schmelzer, Meriden. The preparation was found to be Fowler's solution, and not a solution of arsenous acid.

Both these preparations contain the same limits for arsenous oxide (A_2O_3), viz., 0.975 to 1.025 per cent. and the sample obtained conformed substantially to these limits. It was not, however, the article called for.

HYDROCHLORIC ACID.

29206. Sample of hydrochloric acid, dilute, bought on prescription, R. J. Keefe, Windsor Locks. Required not less than 9.5 per cent. hydrochloric acid; found 9.64 per cent.

Prescription satisfactory.

PHOSPHORIC ACID.

30232. Sample of phosphoric acid, dilute, bought on prescription, Broderick and Curtin, Meriden. Required not less than 9.5 nor more than 10.5 per cent. of phosphoric acid; found 9.4 per cent.

Prescription passed.

POTASSIUM IODIDE.

Three samples were purchased on a prescription calling for 3.5 drachms of potassium iodide and sufficient distilled water to make 1 fluid ounce. Such a solution should contain 45.5 grams of potassium iodide in 100 cc. of solution, assuming 99 per cent. purity for the potassium iodide used.

29987. Purchased of A. C. Roby, Unionville. Potassium iodide found, 46.37 grams per 100 cc.

Solution satisfactory.

30224. Purchased of J. W. Sears, New Haven. Potassium iodide found, 44.78 grams per 100 cc.

Solution passed.

30231. Purchased of F. E. Wilson, Rockville. Potassium iodide found, 46.71 grams per 100 cc.

Solution satisfactory.

29974. This solution had leaked in transit and was not examined.

TABLE XVII. ANALYSES OF

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist
29960	Acetanilid Compound (Acetasal) (Daggett & Miller Co.)	M. J. Dowd: Thompsonville
	Acetanilid 50%	
	Caffeine citrate 2.5%	
	Sodium salicylate	
	Sodium bicarbonate	
29212	Acetanilid Comp. No. 1 (Direct Sales Co.)	F. J. Mann: Southington
	Acetanilid	
	Camphor monobromate	
	Caffeine citrate	
29238	Acetanilid Tablets (Direct Sales Co.)	N. Hibbard: Danielson.
	Acetanilid	
29209	Acetanilid Sodium Comp. (Maltbie Chem. Co.)	H. F. King: Windsor.
	Acetanilid	
	Sodium bicarbonate	
	Caffeine	
	Tinct. Gelsemium	
29962	Acetanilid Tablets[1] (G. S. Stoddard & Co.)	M. J. Dowd: Thompsonville.
	Acetanilid	
29975	Acetanilid Tablets (Tilden Co.)	J. A. Coogan: Windsor Locks.
	Acetanilid	
30208	Acetphenetidin (Direct Sales Co.)	H. F. Moore: Bethel
29249	Acetphenetidin Tablets (Tailby-Nason Co)	R. M. Griswold: Kensington.
	Acetphenetidin	
30220	Acetphenetidin (Mfr?)	L. C. Heidger: Stratford
29959	Aspirin (Abbott Lab.)	T. J. Luby: Hartford
	Aspirin	
29234	Aspirin (American Druggists' Syndicate)	F. P. Clason: Hartford.
	Aspirin	
29929	Aspirin (American Druggists' Syndicate)	Woodward Drug Co: Middletown
	Aspirin	
29939	Aspirin (Bayer Co.)	Plaisted Drug Store: So. Norwalk.
	Aspirin	
29930	Aspirin (Brewer & Co.)	L. Peisner's Park View Pharmacy: Middletown.
	Aspirin	
29240	Aspirin (Buffington, Inc.)	K. T. Phillips: Putnam.
	Aspirin	
29938	Aspirin (De Pill Co.)	*W. H. Jones' Drug Store: Stamford*
	Aspirin	
29237	Aspirin (Direct Sales Co.)	N. Hibbard: Danielson.
	Aspirin	
30207	Aspirin (Direct Sales Co.)	H. F. Moore: Bethel.
	Aspirin	
30217	Aspirin (Drug Products Co.)	L. C. Heidger: Stratford.
	Aspirin	
29935	*Aspirin (Fraser)*	*Leverty's Drug Store: Bridgeport.*
	Aspirin	

[1] Salcelol.

MEDICINAL TABLETS, ETC.

Medicament				Remarks	D. C. No.
Declared, grains per tablet	Found, grains				
	Min.	Max.	Avg.		
2.6	2.2	2.5	2.4		29960
0.13	0.24	0.25	0.24		
....	0.50	0.5	0.5		
....	0.7	0.8	0.7	Excess caffeine citrate.	
2.0	1.7	2.0	1.9		29212
0.5	0.5	0.6	0.5		
2.5	0.5	0.5	0.5	Pass	
5.0	4.6	4.9	4.8	Pass	29238
2.5	2.4	2.6	2.5		29209
2.5	2.1	2.2	2.1		
0.5	0.5	0.5	0.5		
....	....	....	....	Pass (Low in Sod. Bicarbonate)	
2.5	2.4	2.6	2.5	Satisfactory	29962
5.0	4.6	5.6	5.2	Pass	29975
5.0	5.2	5.6	5.3	Satisfactory	30208
5.0	4.8	5.2	5.0	Satisfactory	29249
5.0	4.4	5.0	4.8	Pass	30220
5.0	4.6	4.8	4.7	Pass	29959
5.0	4.3	5.3	4.9	Pass	29234
5.0	4.9	5.7	5.2	Pass	29929
5.0	4.7	5.2	5.0	Satisfactory	29939
5.0	4.6	5.3	5.0	Pass	29930
5.0	4.8	5.0	4.9	Pass	29240
5.0	4.7	5.0	4.9	Pass	29938
5.0	4.9	5.1	5.0	Satisfactory	29237
5.0	4.9	5.1	5.0	Satisfactory	30207
5.0	5.0	5.4	5.1	Satisfactory	30217
5.0	4.3	4.6	4.5	Pass	29935

TABLE XVII. ANALYSES OF

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist
29906	Aspirin (Mfr?)	E. L. Pratt: Winsted.
	Aspirin	
29941	Aspirin (G. F. Harvey Co.)	N. P. Lewis: Norwich
	Aspirin	
29950	Aspirin (G. F. Harvey Co.)	P. A. Park: Bristol.
	Aspirin	
29940	*Aspirin (Lee & Osgood Co.)*	*The Lee & Osgood Co: Norwich.*
	Aspirin	
29933	Aspirin (Lehn & Fink)	Misentis Drug Store: Middletown.
	Aspirin	
29944	Aspirin (H. K. Mulford Co.)	Sisk's Drug Store: Norwich.
	Aspirin	
29218	Aspirin (National Drug Co.)	T. F. Rockwell: Rockville.
	Aspirin	
29239	Aspirin (National Drug Co.)	K. T. Phillips: Putnam.
	Aspirin	
29928	Aspirin (Squibb)	The Gladding Drug Co: Hartford.
	Aspirin	
29966	Aspirin (Surgeons' and Physicians' Supply Co.)	E. O. Elmer: Hartford.
	Aspirin	
29210	Aspirin (Tailby-Nason Co.)	A. P. Pratt: Windsor.
	Aspirin	
29926	Aspirin (United Drug Co.)	Liggett Drug Co: Hartford.
	Aspirin	
30202	Aspirin (The Upjohn Co.)	Geo. D. Wight: Bethel.
	Aspirin	
29945	Aspirin (John Wyeth & Bros)	Branford Pharmacy: Branford.
	Aspirin	
29215	Aspirin (Yates Drug & Chemical Co.)	J. E. Brainard: Wallingford.
	Aspirin	
29901	Aspirin (Yates Drug & Chemical Co.)	A. J. Goodwin: Kensington.
	Aspirin	
29912	Aspirin (Yates Drug & Chemical Co.)	G. W. Eddy: Collinsville.
	Aspirin	
940 [1]	Blaud's Iron Pills (United Drug Co.)	
	Ferrous Carbonate	
30206	Calcium, Iodized (Direct Sales Co.)	J. L. Pons: Bridgeport.
	Total iodine	
	Avail. iodine	
29229	Calcium Sulphide Pills (Upjohn Co.)	J. H. Desmarais: Bristol.
	Calcium Sulphide	
29230	Calcidin (Abbott Laby.)	E. R. Storrs: Hartford.
	Avail. iodine	
29222 } 30223 }	Calomel (Yates Drug & Chemical Co.)	E. H. Metcalf: Rockville
	Mercurous chloride	
29991	Calomel (Smith Pharmacal Co.)	W. E. Hills: Naugatuck
	Mercurous chloride	
29919	Corrosive Sublimate (Davis, Rose & Co.)	The Valley Pharmacy: Collinsville
	Mercuric chloride	

[1] Station Sample.

MEDICINAL TABLETS, ETC.

Medicament				Remarks	D. C. No.
Declared, grains per tablet	Found, grains				
	Min.	Max.	Avg.		
5.0	4.5	5.0	4.7	Pass	29906
5.0	5.0	5.3	5.1	Satisfactory	29941
5.0	5.0	5.2	5.1	Satisfactory	29950
5.0	4.8	5.3	5.0	Satisfactory	29940
5.0	4.9	5.3	5.1	Satisfactory	29933
5.0	4.7	5.1	4.9	Pass	29944
5.0	4.8	4.9	4.9	Pass	29218
5.0	4.9	5.6	5.2	Pass	29239
5.0	4.7	4.9	4.8	Pass	29928
5.0	4.8	4.9	4.9	Pass	29966
5.0	4.9	5.3	5.1	Satisfactory	29210
5.0	4.4	5.0	4.7	Pass	29926
5.0	4.7	5.1	4.8	Pass	30202
5.0	4.7	5.1	5.0	Satisfactory	29945
5.0	4.6	5.2	5.0	Pass	29215
5.0	4.8	5.7	5.3	Pass	29901
5.0	4.8	5.1	5.0	Satisfactory	29912
1.0	1.0	1.2	1.1	Satisfactory	940[1]
....	....	....	0.05		30206
....	....	....	0.003	No standard for comparison	
1.0	0.9	1.0	1.0	Satisfactory	29229
0.15[2]	0.18	0.20	0.18	Pass	29230
0.10	0.11	0.12	0.11	Satisfactory	{ 29222 30223
0.25	0.24	0.27	0.26	Satisfactory	29991
6.9[3]	7.4	7.7	7.5	Satisfactory	29919

[2] Claim, 1 grain calcidin, contains 15% avail. iodine.
[3] Not less than 0.45 gm. not more than 0.55 gm. = 6.9—8.5 grains.

TABLE XVII. ANALYSES OE

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist
30227	Corrosive Sublimate (Davis, Rose & Co.)	The Congress Pharmacy: Ne Haven.
	Mercuric chloride	
30228	Corrosive Sublimate (Morgenstern & Co.)	M. Epstein: New Haven.
	Mercuric chloride	
29219	Coryza No. 2 (G. S. Stoddard & Co.)	T. F. Rockwell: Rockville.
	Potass. bromide	
	Camphor	
	Quinine, strychnine and atropine	
	Salicylic acid	
	Acetanilid	
	Acetphenetidin	
30209	Hexamethylenamine (Direct Sales Co.)	H. F. Moore: Bethel.
	Hexamethylenamine	
29226	Hexamethylenamine (Buffington, Inc.)	R. A. Richardson: Bristol.
	Hexamethylenamine	
30212	Hex-Iodine Lozenges (Daggett & Miller Co.)	D. R. Howland: Stratford.
	Hexamethylenetetramine	
	Iodine	
	Ash	
	Sugar	
	Menthol and undetermined	
29908	Hydrastin-Strychnine Trit. (Smith Pharmacal Co.)	E. R. Kelsey: Winsted.
	Hydrastine and strychnine, as total alkaloids	
29228	Migraine Tablets No. 8 (Nat. Drug Co.)	F. M. Hamblin: Bristol.
	Acetanilid	
	Morphine sulphate	
	Sodium salicylate	
	Caffeine	
	Sodium bicarbonate	
	Capsicum	
29225	Migraine Tablets (Tailby-Nason Co.)	R. A. Richardson: Bristol.
	Acetanilid	
	Caffeine	
	Camphor monobromate	
29932	Morphine Sulphate (Hypoderm.) (John Wyeth & Bros.)	J. E. Loveland: Middletown.
	Morphine sulphate	
29247	Nitroglycerine Tablets (Nat. Drug Co.)	T. C. Hodgson: Berlin.
	Nitroglycerine	
29213	Phenolphthalein Tablets (Direct Sales Co.)	F. J. Mann: Southington.
	Phenolphthalein	
29915	Quinine Sulphate (G. F. Harvey Co.)	R. B. Cox: Collinsville.
	Quinine sulphate	
29924	*Quinine Sulphate (Standard Laby.)*	*C. T. Baldwin: Derby.*
	Quinine sulphate	

MEDICINAL TABLETS, ETC.

Medicament				Remarks	D.C. No.
Declared, grains per tablet	Found, grains				
	Min.	Max.	Avg.		
6.9 [1]	6.6	7.3	6.9	Satisfactory	**30227**
7.3	7.0	8.0	7.6	Pass	**30228**
0.167	....	....	0.161		**29219**
0.25	....	....	0.20		
0.111 [2]	....	....	0.097 [3]		
...	....	....	0.03		
....	....	....	0.10		
....	....	....	0.005?	Pass	
5.0	4.8	5.0	4.9	Pass	**30209**
5.0	4.8	4.9	4.9	Pass	**29226**
....	....	....	10.52 [4]		**30212**
....	....	....	0.17 [4]		
....	....	....	2.41 [4]		
....	....	....	80.00 [4]		
....	....	....	6.90 [4]	Pass	
0.010 [2]	....	....	0.008 [3]	Pass	**29908**
2.5	2.1	2.4	2.2		**29228**
0.05	0.05	0.05	0.05		
1.75	1.41	1.60	1.48		
0.25	0.23	0.26	0.24		
1.0	1.0	1.1	1.0		
0.05	....	....	....	Pass (Low in sodium salicylate)	
2.0	2.0	2.1	2.0		**29225**
0.25	0.24	0.26	0.25		
0.5	0.5	0.5	0.5	Satisfactory	
0.125	0.120	0.140	0.130	Pass	**29932**
0.01	0.01	0.01	0.01	Satisfactory.	**29247**
2.0	2.0	2.3	2.2	Pass	**29213**
2.0	1.9	2.2	2.1	Pass	**29915**
2.0	1.8	1.9	1.9	Pass	**29924**

[1] Not less than 0.45 gm. nor more than 0.55 gm. = 6.9 – 8.5 grains.
[2] Calc. for mixed alkaloids.
[3] Mixed alkaloids.
[4] Percentages. Claimed to contain hexamethylenetetramine and iodine.

TABLE XVII. ANALYSES OF

D. C. No	Drug and Manufacturer	Stock of Doctor or Druggist
29246	Quinine Sulphate (National Drug Co.)...	T. C. Hodgson: Berlin.
	Quinine sulphate..................	....
30203	Quinine Sulphate (Yates Drug & Chemical Co.)...........................	J. D. Eggleston: Meriden.
	Quinine sulphate..................	....
29910	Sedative Pills No. 3 (G. F. Harvey Co.)..	R. V. Sanderson: Winsted.
	Camphor, asafoetida and valerian.....	....
29953	Sodium Bromide (Am. Drug. Syndicate)..	Devita Pharmacy: New Haven.
	Sodium bromide....................	....
29978	Sodium Bromide (Tailby-Nason Co.)....	H. Boyd: So. Manchester.
	Sodium bromide....................	....
29236	Triple Bromides (Tailby-Nason Co.).....	G. T. Lamarche: Putnam.......
	Potassium bromide.................	....
	Sodium bromide....................	....
	Ammonium bromide..................	....
29961	Sodium Salicylate (Daggett & Miller Co.)	M. J. Dowd: Thompsonville.
	Sodium salicylate.................	....
30214	Sodium Salicylate (Daggett & Miller Co.)	D. R. Howland: Stratford.
	Sodium salicylate.................	....
29214	Sodium Salicylate (Direct Sales Co.).....	F. J. Mann: Southington.
	Sodium salicylate.................	....
29221	Sodium Salicylate (Direct Sales Co.).....	E. H. Metcalf: Rockville.
	Sodium salicylate.................	....
29951	Sodium Salicylate (G. F. Harvey Co.)....	P. A. Park: Bristol.
	Sodium salicylate.................	....
29208	Sodium Salicylate (Rheumatic Tablets) (Maltbie Chem. Co.)...............	H. F. King: Windsor.
	Sodium salicylate.................	....
	Sodium bicarbonate................	....
	Wine colchicum seed...............	....
29931	Sodium Salicylate (Haberle Drug Co.)...	H. L. Burr: Middletown
	Sodium salicylate.................	....
29923	Sodium Salicylate (Standard Laby.).....	C. T. Baldwin: Derby.
	Sodium salicylate.................	....
29920	Sodium Salicylate (R. J. Strasenburg Co.)	E. P. Dunne: Unionville.
	Sodium salicylate.................	....
29248	Sodium Salicylate (Syracuse Pharmacal Co.)...........................	R. M. Griswold: Kensington.
	Sodium salicylate.................	....
29248 D	Duplicate of **29248** (Syracuse Pharmacal Co.)...........................	R. M. Griswold: Kensington.
	Sodium salicylate.................	....
29235	Sodium Salicylate Comp. (Tailby-Nason Co.)...........................	G. T. Lamarche: Putnam.
	Acetanilid........................	....
	Caffeine..........................	....
	Sodium salicylate.................	....
	Sodium bicarbonate................	....

MEDICINAL TABLETS, ETC.

Medicament				Remarks	D. C. No.
Declared, grains per tablet	Found, grains				
	Min.	Max.	Avg.		
2.0	1.7	1.9	1.8	Pass	29246
2.0	2.0	2.3	2.2	Pass	30203
....	....	....	....	Pass (Camphor and asafoetida present, amount not determined	29910
5.0	4.7	5.3	5.0	Pass	29953
10.0	9.6	9.9	9.8	Pass	29978
2.5 2.5 2.5	2.6 2.4 2.5	2.8 2.5 2.6	2.7 2.5 2.5	Pass	29236
5.0	4.9	5.1	5.0	Satisfactory	29961
5.0	3.6	3.8	3.7	Low	30214
5.0	4.6	4.9	4.8	Pass	29214
5.0	4.9	5.2	5.1	Satisfactory	29221
5.0	4.0	5.2	4.7	Pass	29951
7.5 2.5	7.2 2.5	7.5 2.6	7.4 2.5	Pass	29208
5.0	4.8	5.3	5.2	Satisfactory	29931
5.0	4.4	5.1	4.8	Pass	29923
5.0	4.7	5.0	4.9	Pass	29920
5.0	3.8	4.0	3.9	Low	29248
5.0	3.8	4.0	3.9	Low	29248D
2.5 0.25 1.75 1.0	2.4 0.23 1.76 0.9	2.6 0.25 1.92 1.0	2.5 0.24 1.83 1.0	Satisfactory	29235

TABLE XVII. ANALYSES OF .

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist
29903	Sodium Salicylate (Tailby-Nason Co.)....	E. G. Reade: Watertown.
	Sodium salicylate........	....
29967	Sodium Salicylate (Tailby-Nason Co.)....	E. O. Elmer: Hartford.
	Sodium salicylate........	....
29946	Sodium Salicylate (Yates Drug & Chemical Co.)........	A. S. McQueen: Branford.
	Sodium salicylate........	....
30211	Sodium Salicylate (Yates Drug & Chemical Co.)........	H. D. Lockwood: Meriden.
	Sodium salicylate........	....
29914	Strontium Salicylate (Daggett & Miller Co.)........	R. B. Cox: Collinsville.
	Strontium salicylate........	....
29905	Strontium Salicylate (Tailby-Nason Co.).	E. L. Pratt: Winsted.
	Strontium salicylate........	....
29969	Strychnine Sulphate (A. D. S.)........	Ebbs Drug Co.: Waterbury.
	Strychnine sulphate 1/30........	....
29216	Strychnine Sulphate (Daggett & Miller Co.)........	I. E. Brainard: Wallingford.
	Strychnine sulphate 1/60........	....
29216 D	Duplicate of **29216** (Daggett & Miller Co.)	I. E. Brainard: Wallingford.
	Strychnine sulphate 1/60........	....
29900	Strychnine Sulphate (Glen Pharmacal Co.)	R. M. Griswold: Kensington.
	Strychnine sulphate 1/60........	....
30219	Strychnine Sulphate (The G. F. Harvey Co.)........	L. C. Heidger: Stratford.
	Strychnine sulphate 1/60........	....
29211	Strychnine Sulphate (Nat. Drug Co.)....	A. P. Pratt: Windsor.
	Strychnine sulphate 1/30........	....
30210	Strychnine Sulphate (Yates Drug & Chemical Co.)........	H. DeF. Lockwood: Meriden.
	Strychnine sulphate 1/30........	....
29916	Thyroid (Desiccated) Tablets (G. F. Harvey Co.)........	R. B. Cox: Collinsville.
	Equivalent to 10 grains fresh thyroid.	
	Iodine in thyroid combination........	....
29989	Thyroid (Desiccated) Tablets (G. F. Harvey Co.)........	R. B. Cox: Collinsville.
	Same as **29916**........	....
29911	Valerian Compound (Tailby-Nason Co.)	R. V. Sanderson: Winsted.
	Barbital........	....
	Valerian........	....
	Hyoscyamus........	....
	Asafoetida........	....

MEDICINAL TABLETS, ETC.

Medicament				Remarks	D. C. No.
Declared, grains per tablet	Found, grains				
	Min.	Max.	Avg.		
5.0	4.5	5.0	4.8	Pass	29903
5.0	4.6	4.8	4.7	Pass	29967
5.0	4.7	5.1	4.8	Pass	29946
5.0	4.9	5.5	5.2	Pass	30211
5.0	4.5	4.8	4.6	Pass	29914
5.0	4.8	5.2	5.0	Satisfactory	29905
0.033	0.032	0.037	0.035	Pass	29969
0.017	0.022	0.025	0.023	Excess strychnine sulphate	29216
0.017	0.020	0.022	0.022	Excess strychnine sulphate	29216D
0.017	0.018	0.021	0.020	Pass	29900
0.017	0.013	0.015	0.014	Pass	30219
0.033	0.033	0.040	0.038	Pass	29211
0.033	0.031	0.039	0.034	Pass	30210
0.0034 [1]	0.0037	0.0050	0.0046	Satisfactory	29916
0.0034 [1]	0.0032	0.0046	0.0037	Satisfactory	29989
0.25	....	....	0.24		29911
....	....	....	....		
....	....	....	....		
....	....	....	....	Pass (asafoetida present; valerian and hyoscyamus not identified	

[1] Ten grains fresh thyroid = 2 grains dry. Dry thyroid contains not less than 0.17 or more than 0.23 per cent. iodine in thyroid combinations = 0.0034 to 0.0046 grain.

Drugs Not Purchased on Prescription.

BORIC ACID.

Boric acid of the purity prescribed by the U. S. Pharmacopoeia contains, in the dried powder, not less than 99.5 per cent. of boric acid, H_3BO_3.

29224. Sample purchased at Wilson Pharmacy, Willimantic, (Brewer and Co. product). It contained 99.04 per cent. of boric acid.
Sample passed.

29223. Sample purchased of C. DeVillers, Willimantic. (20 Mule Team brand). It contained 99.0 per cent. of boric acid.
Sample passed.

CALCIUM HYDROXIDE SOLUTION

Lime water should contain not less than 0.14 per cent. of calcium hydroxide $Ca(OH)_2$.
Samples examined are listed in the following summary.

Analyses of Lime Water.

D. C. No.		Druggist	Calcium hydroxide Ca(LH)₂ found %
29918	*Collinsville*	Valley Pharmacy.........	0.17
30226	*New Haven*	State Pharmacy..........	0.17
30225		J. P. Gillespie & Co.......	0.16
30234	*Wallingford*	Moran's Drug Store......	0.17
30236	*Waterbury*	Apothecaries Hall Co......	0.02
29947	*Winsted*	The Case Drug Store.....	0.17

Sample **30236** deficient in lime.

CALOMEL.

One sample purchased by the Station agent, **953**, Merck's product, was found to contain 99.8 per cent. of mercurous chloride. The U. S. Pharmacopoeia requires not less than 99.6 per cent.
Sample satisfactory.

MONOBROMATED CAMPHOR.

No assay for this product is given in the U. S. Pharmacopoeia although certain specifications for it are defined.

29981. Sample purchased of John J. Cronin, Middletown, Merck's. Assayed by the tentative method[1] it was found to closely approximate 100 per cent. monobromated camphor.
Sample satisfactory.

[1] J. A. O. A. C.

SOLUTION OF CITRATE OF MAGNESIA.

27877. This preparation was made and distributed by A. K. Shupis, Stamford. It contained 1.07 gms. of magnesium oxide (MgO) per 100 cc., whereas the U. S. Pharmacopoeia requires not less than 1.5 gms. per 100 cc.

Sample below standard.

COLLODION.

This preparation unless otherwise specified, should be of the contractile type and contain not less than 5.1 per cent. of pyroxylin.

29988. Sample purchased of J. G. McNamara, Collinsville. It contained 5.75 per cent. of pyroxylin and otherwise conformed to the specifications for collodion except for a faint acidity and the probable presence of amyl acetate, the odor of which was apparent on evaporation.

Sample passed.

SYRUP OF FERROUS IODIDE

This preparation should contain not less than 4.75 nor more than 5.25 per cent. of ferrous iodide, FeI_2.

29949. Sample purchased at Claxton's Drug Store, Torrington. It contained 5.25 per cent. of ferrous iodide.

Sample satisfactory.

TINCTURE OF IODINE.

This preparation should contain not less than 6.5 nor more than 7.5 grams of iodine, and not less than 4.5 nor more than 5.5 grams of potassium iodide per 100 cc.

29921. Sample purchased at the Thompsonville Drug Co., Thompsonville. It contained 6.55 grams of iodine and 4.56 grams of potassium iodide per 100 cc.

Sample satisfactory.

29207. Sample purchased at the Bridge Pharmacy, Windsor Locks. It contained 6.95 grams of iodine and 5.07 grams of potassium iodide in 100 cc.

Sample satisfactory.

30230. Sample purchased at the Powell Drug Co., East Hartford. It contained 6.70 grams of iodine and 4.63 grams of potassium iodide, per 100 cc.

Sample satisfactory.

ESSENCE OF PEPPERMINT.

This preparation should contain 10 per cent. by volume of oil of peppermint.

The samples examined are summarized as follows:

No.		Druggist	Peppermint oil, per cent.
30248	*Putnam*	J. A. P. Gagne	4.0
30247		G. N. Lemaitre	11.3
30400	*Torrington*	South End Pharmacy	9.5
30401		Park Pharmacy	13.9
30402		Claxton's Pharmacy	10.9
29948	*Winsted*	City Pharmacy	7.7
29948D		City Pharmacy	10.7
30249		Albert Decsi	12.4

Two samples **30248** and **29948** were deficient in peppermint oil. A second sample of one of these, **29948D**, was of required strength.

SWEET OIL.

29922. Sweet Oil, Pleasant St. Pharmacy, Thompsonville. No oil other than olive oil should be dispensed as sweet oil. This sample responded to the tests for genuine olive oil.

Sample passed.

TOILET PREPARATIONS.

These products have been examined chiefly in accordance with Section 2679 of the General Statutes which prohibits the use of wood alcohol in the compounding of any toilet lotion.

Eleven samples of hair tonic, three of bay rum, and two of witch hazel were examined but no wood alcohol was detected.

Two samples of hair tonic, **29972** and **22973**, sold by E. J. Mangini of Waterbury have no declaration of the percentage of alcohol present. They contained 45 and 57 per cent. respectively.

Wild Root Hair Tonic, **29963**, Wildroot Co., Inc., sold by A. Seidman, Hartford, contained 23 milligrams of arsenic per 100 cc.

Another preparation containing arsenic was brought to our attention by a purchaser. This was an original bottle labelled KDX Dandruff Exterminator, **22704**, Koken Companies, St. Louis. The preparation was found to be a dilute, alkaline, alcoholic solution containing 93 milligrams of arsenic (As) per 100 cc. of solution, with a salicylate and glycerin. Other medicaments, if present, not identified.

Medical and other literature contain conflicting data upon the effects of arsenic. Its external application may develop pustules, vesicles and erysipelatoid inflammation of the skin[1]; but it is further noted that many forms of skin disease, such as chronic eczema, are treated with arsenic with beneficial results[2]. Absorption takes place to some extent through the intact skin so that poisoning may result from the external use of arsenical cosmetics;[3]

[1] Cushny. *Pharmacology and Therapeutics*, p. 595.
[2] Ibid, p. 602.
[3] Sollmann. *Manual of Pharmacology*, p. 737.

but improved nutrition of the skin and hair is said to be effected by external and internal treatment with arsenic.[1] Another authority[2] cites instances of poisoning, particularly the death of a child following the application of an arsenical ointment for scalp eruption. "Arsenic pock"[3] is a term used to designate arsenical ulcers of the hands in the case of color workers and others engaged in handling arsenical materials.

There appears to be no question that arsenic constitutes a potential source of injury and that its indiscriminate use in toilet lotions and hair tonics is attended with danger.

27244. *Boncilla Clasmic Pack.* Crown Chemical Co., Indianapolis, Ind. Sample submitted by a purchaser through the office of the Dairy and Food Commissioner.

Loss on drying at 100° C. (chiefly moisture), 48.30 per cent., organic and volatile 4.09 per cent., ash 47.61 per cent. Silica, iron, aluminum and manganese considerable, calcium magnesium and sodium small amount, carbonate and sulphate small amount, phosphate trace, organic extractives negligible amount, no vesicating principles found, glycerine present, arsenic not detected.

The preparation consists essentially of perfumed clay (iron-aluminum silicate), glycerine and water with a little calcium carbonate. The composition is quite typical of so-called beauty clays.

27245. *Cold Cream.* Brand not known. Submitted by a purchaser who used it in conjunction with beauty clay, **27244,** and suffered irritation of the skin.

The cream was almost completely soluble in ether and besides the fatty base and perfume nothing was found. No vesicating principles or arsenic were detected.

PROPRIETARY REMEDIES, ETC.

22530 A. *Sun and Moon Sacred Anointing Oil.* Prepared by A. W. Lowrie, Inc., Hartford. Recommended for external or internal use. Sample submitted by the Commissioner of Public Health through the office of the Dairy and Food Commissioner. The preparation consisted of yellow, limped oil with a small layer of brown solution containing some sediment. The odor of methyl salicylate was apparent and the reaction was slightly acid to litmus.

Partial analysis:

Moisture and volatile at 100°C., 10.48 per cent.; residue at 100°C (largely oil), 89.52 per cent.; ash trace; alcohol by weight 1.91 per cent.; salicylate present; alkaloids none found; refraction of oil at 25° C 62.2° (butyro-refractometer scale); iodine No. of oil 64; Halphen test on oil negative. Oil almost completely saponifiable.

[1] Sollmann. *Manual of Pharmacology*, p. 742.

[2] Peterson, Haines and Webster. *Legal Medicine and Toxicology*, p. 218.

[3] Kober and Hayhurst. *Industrial Health.*

The examination shows that the medicine consists substantially of a fixed oil, methyl salicylate and a small amount of vegetable extractive material in dilute alcohol.

22530 B. *Sun and Moon Sacred Ointment.* This is another sacred remedy of the same manufacturer.

Partial analysis:

Moisture and volatile at 100°C 8.27 per cent.; residue at 100° C (fatty base) 91.73 per cent.; ash trace; salicylate present; alkaloids not found; menthol none found. Fat largely unsaponifiable; fluorescent in ether solution.

The ointment consists of a fatty base (probably petrolatum), a little saponifiable fat or oil with methyl salicylate as the chief or only active ingredient.

The remedy is proclaimed by the manufacturer as "A food for the body to destroy disease" and is further claimed to contain "vibrations of life from the radio-activity of electricity magnetism, electrons and atoms." This meaningless jumble of scientific terms serves to introduce the element of mystery upon which the "patent medicine" man generally depends for the appeal of his wares. In this instance the mystery is fortified with alleged sacredness.

29450. *Nature's Vital Food.* Manufactured by A. S. Maine, Westerly, R. I. Sample submitted by Dr. Osborne, Health Commissioner, through the office of the Dairy and Food Commissioner.

The label on the bottle says, in part, that this remedy is a special preparation of 32 kinds of roots, herbs, barks and gums; that it is a *blood purifier* the use of which *makes possible the cure* of thousands of the most virulent cases of cancer, etc. This implies that the remedy effects such cures. On reading the literature which goes with the package however, it appears that this medicine is used as a tonic to fit the patient for the Main's special cancer treatment which consists, apparently, of drawing out the cancer by means of plasters. On the reverse side of the label appears the claim that the remedy is a preventive of cancers, tumors, syphilis, and a number of other diseases. On the carton it says, in part: "An internal medicine for all aliments of the human body—removing the cause of your disease, thereby rendering a permanent cure.

The preparation is a dark brown liquid with some sediment, acid to litmus, and having a disagreeable odor.

Analysis was made as follows:

Water and volatile at 100°C 98.82 per cent.; solids 1.18 per cent.; ash 0.27 per cent.; iron, calcium, magnesium sodium, potassium, sulphate and phosphate present; chloride trace; zinc trace (?); anthraquinone derivatives present; bitter and pungent principles present; asafoetida, rhubarb, gentian and capsicum indicated; aloes not found; benzoic acid present, (0.04%); salicylic and citric acids not found; hypophosphites, antipyrin, acetphenetiden, acetanilid, pyramidon, iodine and alcohol not found; alkaloids none or trace.

The examination shows that the preparation is an aqueous solution of vegetable extractives consisting wholly, or in part, of vegetable cathartics with bitter and pungent principles; and containing a small amount of benzoic acid and some vegetable tissue.

The mineral constituents are insignificant, as shown by the small amount of ash, and are only such as are generally present in the ash of vegetable matter.

The labeling of this product is an example of misbranding at its worst.

21850. *Volta.* Prepared and distributed by the Volta Company of America, Inc., Philadelphia, Pa. Sample purchased by the Station agent at Wood's Drug Store, New Haven.

Analysis:

Free sulphur 86.74 per cent;. aluminum oxide 3.20 per cent.; iron oxide 0.74 per cent.; phosphate trace; carbonate, borate, chloride and soluble sulphate none found; alkaloids none found; starch none; methyl salicylate present.

The analyses indicates that the preparation is essentially a mixture of sulphur, iron and aluminum oxides, with methyl salicylate and possibly some other aromatic substance.

The product is not labeled as a cure or a remedy, but states that it is adapted to the treatment of rheumatism, sciatica, etc.

21851. *Erbjus.* Prepared by the Erbjus Remedy Co., Bridgeport, Conn. Sample purchased by the Station agent at Wood's Drug Store, New Haven. A tonic "made with herb juice and glycerine. Non-alcoholic, for stomach, kidney, liver, rheumatism and bowels."

Analysis showed the following composition:

Water (in vacuo at 60° C), 84.80 per cent.; ash 0.53 per cent.; glycerine 10.74 per cent.; sugar, as dextrose, 1.75 per cent.; salicylic acid 0.43 per cent; undetermined 1.75 per cent. Qualitative tests showed the presence of salicylic acid, anthraquinone derivatives, glycerine, sugar and citrates(?) No other medicaments were detected. Alkaloids and aloes not found. Manganese was present in the ash but other ash constituents were not investigated.

The preparation appears from the analysis to be a solution of vegetable cathartics and bitters in glycerine and water. No curative claims for the article are made.

21847. *Dr. Edward's Olive Tablets.* The Olive Tablet Co., Columbus, Ohio. A substitute for calomel. Sample purchased by the Station agent at York Pharmacy, New Haven.

These are olive-green, sugar coated pills averaging in weight a little less than 3 grains each.

Examination and partial analysis:

Qualitative tests showed the presence of aloes; ginger, sugar, calcium (large amount), and iron. Starch, alkaloids, jalap and mercury not

detected. Quantitative determinations showed moisture and volatile at 100°C. 5.86 per cent.; ash (chiefly calcium carbonate), 13.93 per cent; petroleum ether extract non-volatile at 100° C. 1.15 per cent.

The tablets contain aloes and ginger as the essential medicaments.[1]

30216. *Dakol.* The Dakol Co., New Haven. Samples by the Dairy and Food Commissioner. This is a nasal cream.

Examination:

Qualitative tests showed the base to consist largely of saponifiable fat with menthol and creosote or guiacol indicated. (The odor of creosote was apparent in one of the factions but tests for it were negative).

23367. *Ovelmo Blood Tonic and Restorative,* Ovelmo Co., Fort Wayne, Ind. Sample submitted by a purchaser. Red tablets, average weight 0.681 gram. Not labelled as a cure.

Analysis:

Moisture 4.00 per cent.; ash 37.43 per cent.; insol. ash, talc. etc., 2.90 per cent.; iron and aluminum oxides 8.25 per cent.; calcium oxide 9.62 per cent.; magnesium oxide 1.10 per cent.; sodium oxide 4.27 per cent.; potassium oxide 0.35 per cent.; sulphur trioxide 6.39 per cent.; phosphorus pentoxide 0.10; chlorine 0.15 per cent; carbon dioxide present, not determined; nitrogen 0.38 per cent; sugar 35.59 per cent; starch 6.80 per cent; cellulose (fiber) 3.71 per cent; ether extract 1.83 per cent; emodin-like substance present; alkolaids none found.

The tablets consist substantially of ferrous sulphate, bicarbonate of soda, carbonates of lime and magnesia, sugar, starch, a small amount of emodin-like substances (vegetable cathartics), and other vegetable extractives. No alkaloids were found.

23368. *Ovelmo Digestive Tablets.* Ovelmo Co., Fort Wayne, Ind. Sample submitted by a purchaser. Black tablets, average weight 0.347 grams. Not labelled as a cure.

Analysis:

Moisture 6.75 per cent.; ash 38.35 per cent.; insol. ash 2.30 per cent.; iron and aluminum oxides 2.25 per cent.; calcium oxide 9.25 per cent.; magnesium oxide 9.64 per cent; sodium oxide 6.23 per cent; potassium oxide 0.45 per cent; phosphorus pentoxide 0.40 per cent; chlorine 0.40 per cent; carbon dioxide present, amount not determined; sulphur trioxide none; nitrogen 0.35 per cent; sugars 25.02 per cent; starch 10.80 per cent; cellulose (fiber) 5.19 per cent; ether extract 1.48 per cent.; emodin-like substances indicated; charcoal present; alkaloids none found; diastase and pepsin not tested for.

These tablets consist of, or contain, bicarbonate of soda, carbonates of lime and magnesia, starch, sugar and charcoal. Emodin-like substances are indicated, and digestive ferments may be present.

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[1] See also Conn. Exp. Sta. Report for 1914, p 310.

Both these Ovelmo products were purchased on the mail order plan and were being used by the purchaser to cure eczema. In the literature of the American Medical Association we find reference to an "Ovelmo Company" of Fort Wayne which did a mail order business in preparations for the cure of skin diseases until Federal interference finally disrupted the organization. Whether the old concern has been revived under new management, or whether the similarity of name, methods and purposes of the present company is merely a coincidence we cannot say. At any rate, we advised the purchaser of these remedies to consult his physician or a specialist in skin diseases.

D. C. 30221. *Mineral Water.* Luippold Mineral Water Co., Inc., Bridgeport, Conn. This is a carbonated water and analysis was made after carbon dioxide had been largely removed. Results are expressed as milligrams per liter.

Analysis:

Total solids at 100°C. 8970; after ignition 6870; silica 14.5; iron and aluminum oxides (largely ferrous iron), 30; potassium oxide 60; sodium oxide 2176.9; magnesium oxide 586.4; calcium oxide 1010; strontium oxide trace?;maganese oxide 15; chloride (Cl), 4345; sulphate (SO_3), 446; phosphate (P_2O_5), none; carbon dioxide present.

The water contains chiefly chlorides of sodium, megnesium and calcium with smaller amounts of other mineral salts. It is a natural mineral water, carbonated.

Collateral advertising stressed curative features of the product and was objectionable as were certain claims made on the label itself. A representative of the company, in conference with the Dairy and Food Commissioner, advised that the advertisement cited was the only one of its kind that had appeared and that it would not be repeated; and that the label had already been revised.

Miscellaneous Drugs.

Miscellaneous drugs and chemicals for identification or other examination have been submitted, chiefly by health or other public officials, and are summarized in Table XVIII.

TABLE XVIII. MISCELLANEOUS DRUGS ETC.

No.	*Name of drug, etc.*	*Remarks.*
D. C. 29464	Alcohol	No wood alcohol found. Trace of diethylphthalate present.
28223 / **22824**	Ampules of silver nitrate.	Tested for acidity. Faint acidity was demonstrated but no evidence that it was sufficient in kind or amount to cause injury when applied to the eyes, was obtained.
639	Boric acid	Found to be 98.6 per cent. pure.
506	Hank's Chemical (fire extinguisher)	About 99 per cent. bicarbonate of soda colored with iron salt.
D. C. 29425	Medicine. (Prescription).	Prescription called for ammonium and potassium bromides, aromatic spirits of ammonia, camphor and water. Total bromides calculated 9.4 gms. per 100 cc, found 8.7 gms. Ammonia and camphor present. Medicaments substantially as called for.
22374	Medicine	A syrupy solution containing iron and vegetable cathartics. No other medicaments detected.
D. C. 29419	Medicine	Found: Alcohol 7.8 per cent., sodium bromide 12.28 per cent., glycerine 22.46 per cent. phenolphthaline present, pepsin indicated, iron, potassium and phosphates traces, alkaloids and arsenic none found. Medicine consists of a sedative, laxative, pepsin, alcohol, glycerine and water.
D. C. 28618	Preserving Powder F.L.P.	Consists substantially of salt and chili saltpeter. (Nitrate of soda.)
D. C. 28074	B. Salt	Consists essentially of salt and nitrate of soda or saltpeter and red pepper.
D. C. 28779	Preservaline	Contains 93.27 per cent. of sodium sulphite. No borax.
22347	Sodium hydroxide solution	Found to be 1.126 stronger than tenth normal.
22591	Stain for poultry feathers	Appeared to be commercial turpentine, or turpentine and a light oil.
143	Unknown substance	Identified as plaster of Paris (calcium sulpbate).

BABCOCK GLASSWARE, ETC.

The following is a summary of Babcock glassware checked during the year. Lactometers and thermometers were compared with certified instruments for the Dairy and Food Commissioner.

	Total	Broken in transit*	Accurate	Inaccurate
Cream	585	3	537	45
Milk test bottles	2707	29	2652	21
Pipettes	556	20	533	3
Acid measures	1	0	1	0
Lactometers	17	0	17	0
Therometers	8	0	8	0
Totals	3869	52	3748	69

BULLETIN 268 MARCH 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REPORT ON INSPECTION OF COMMERCIAL FEEDING STUFFS 1924

E. M. BAILEY

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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March, 1925.

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The Wilson H. Lee Co.

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THE NEW LAW•RELATING TO FEEDING STUFFS.

A law relating to Concentrated Commercial Feeding Stuffs was passed by the General Assembly, session of 1925, and is now in force. Rules and regulations for enforcement of the law will be issued, as provided in the act, but the essential provisions as they differ from the old law may be here noted. Copies of the law may be obtained from this Station upon request.

"Concentrated Commercial Feeding Stuffs" defined. Section 1 of the law defines the term "concentrated commercial feeding stuffs" in substantially the same way that it is defined in the old law; and with the same exemptions. Scratch grains are classed as concentrated feeds.

Labelling. Section 2 defines how concentrated commercial feeding stuffs shall be labelled. The label must declare (1) the number of net pounds of feed in the package; (2) the name, brand or trade mark under which the article is sold; (3) the name and address of the manufacturer or importer; (4) a statement of the minimum percentages of (a) crude protein, (b) crude fat, and (c) the maximum percentage of crude fiber; and (5) in case of feeds composed of two or more ingredients, the name of each ingredient contained therein.

Registration and registration fee. Section 3 requires the annual registration of concentrated commercial feeding stuffs and a registration fee of fifteen dollars ($15.00) for each brand. Registration is to be made with the Connecticut Agricultural Experiment Station on or before September 1, 1925, and annually thereafter.

Duties of Manufacturers. Manufacturers, jobbers or individuals shipping feeds into Connecticut will be expected to register their brands and pay the necessary fees thereon. Connecticut dealers should assure themselves that the brands they handle are properly registered. In case the manufacturer or jobber outside the State neglects or refuses to register, the dealer who handles such feeds will be held responsible for such registration and registration fee.

Dealers within the State who mix their own brands are responsible for the registration and proper labelling thereof.

Cottonseed Meal. Cottonseed meal registered as required by the fertilizer law is not exempt from registration also under the feed law if sold for feeding purposes.

Meaning of "Brand". It is held that a distinct brand name or a distinct guaranty constitutes a distinct brand.

Affixing Tags. The use of wire or any metal in affixing tags is prohibited by law.

Commercial Feeding Stuffs.

E. M. Bailey.*

RÔLE OF THE NUTRIENTS.

Water. Air dry feeding stuffs, whether concentrates or roughage, still contain some moisture which cannot be seen or felt. The amount of such moisture averages not far from ten per cent. While not a nutrient in the ordinary sense, water is essential to the animal; but since it is obtained in abundance from sources other than the feed, its presence therein is not of importance. Excessive amounts, however, jeopardize the keeping qualities of a feed and automatically reduce the percentage of the more desirable ingredients.

Ash. The importance of mineral constituents in feeds is emphasized by the fact that animals fed upon rations deprived largely or entirely of ash constituents generally die sooner than animals which have been given no food at all. Given stock mineral matter in addition to that obtained in the daily ration is an old and familiar practice among experienced stockmen who have long "salted their cattle" with common salt (sodium chloride), the commercial grades of which contain small and varying amounts of other minerals, such as calcium, magnesium, iron and phosphorus and sulphur. Recent studies in nutrition have shown some of the specific needs which minerals satisfy in the vital processes. Thus big neck in calves, colts and lambs, and hairlessness in pigs are now attributed to iodine deficiency in the feed; and defective skeletal formation in growing animals is due either to a lack of calcium and phosphorous or to an absence of the necessary agency to make the proper utilization of these minerals possible, for it has been shown that without what has been called the fourth, or antirachitic, vitamine which is present in cod liver oil and in green plant tissues, calcium and phosphorus cannot be properly assimilated.

Protein. This nutrient group is estimated by determining the amount of nitrogen which a feed contains and multiplying that amount by the factor 6.25 on the assumption that proteins uniformly contain 16 per cent. of nitrogen. While this method of estimation is not strictly accurate it is as close an approximation as it is generally possible or practicable to get. From protein the body repairs waste, builds new tissue and, to a lesser extent, derives heat and energy. It was formerly thought that all proteins were adequate for all these processes, but it is a comparatively

*Analyses are chiefly by Messrs. Nolan and Mathis; inspection and sampling by Mr. Churchill; and compilation largely by Miss Bacon.

recent contribution to our knowledge that they are not. Protein is a complex substance made up of nineteen separate parts called amino acids. Proteins which contain some of all the various amino acids are called "complete" proteins; those in which one or more amino acids are lacking are called "incomplete". Undoubtedly all these separate parts play some rôle in vital processes; more particularly we know that tryptophane and lysine are essential to a normal rate of growth. The proteins of cereal grains are relatively low in the two amino acids just mentioned while proteins of animal origin, such as milk, meat, and eggs, are rich in these two substances; thus the logic of supplementing grain rations with skimmed milk or tankage is apparent. Grain mixtures alone may suffice if fed in sufficient quantity but it may happen that the energy requirements of the animal will become satisfied by non-protein constituents of the ration and its appetite fail before enough of the necessary amino acids has been acquired.

Knowledge of digestible nutrients and nutritive rations are not the final criteria by which rations are to be adjusted. The right kind and quality of protein must be supplied.

Crude Fiber. By this term is meant the coarser and more woody tissue characteristic of all forms of roughage and present in the outer coats of cereal and other fodder grains. It belongs to the carbohydrate group and is, in part, digested by ruminant animals. Its chief value lies in its mechanical effect in the intestinal tract.

Nitrogen-free Extract. In this class are included the relatively more digestible carbohydrates of the starch and sugar types. Their principal rôle in nutrition is to supply heat and energy, but they have also the power of sparing protein, by which is meant that when fed together with protein they reduce the amount of the latter food required. An excess of this carbohydrate group over the immediate needs of the body can be transformed into fat and stored in the body tissue.

The term "carbohydrate" as applied to a feeding stuff properly means "crude fiber" and "nitrogen-free extract" combined. Nitrogen-free extract is obtained by deducting from 100 per cent. the sum of the percentages of moisture, ash, protein, fiber and fat (ether extract).

Fat (Ether Extract). Fats, like the carbohydrates, furnish energy to the body and like them also, but to a lesser extent, spare protein. As energy producers their value is 2.25 times greater than that of either carbohydrate or protein. This ether-soluble material is in all cases crude fat, by which we understand that non-fatty substances like chlorophyll and coloring matter may be included therein.

Accessory Nutritive Factors. In this class are included the vitamines. There is not likely to be a deficiency of the vitamines A, B and C in rations of domestic animals; and they will not lack

the antirachitic vitamine if green fodder or properly cured leguminous hay is supplied. The beneficial influence of sunlight upon the growth and development of animals has also been strikingly demonstrated, and it may be classed with the vitamines as an accessory nutritive factor.

Digestible Nutrients.

Coefficients of digestibility for some common commercial concentrates are given in the following table.

Table I. Coefficients of Digestibility of Feeding Stuffs[1]

Feed.	Average dry matter, lbs. per hundred.	Coefficient of digestibility.			
		Protein.	Fiber.	Nitrogen free extract.	Fat.
Cottonseed Meal	92.2	84	37	75	95
Cottonseed Feed	91.7	58	45	61	90
Linseed Meal (Old Process)	90.9	89	57	78	89
Wheat Bran	89.9	78	31	72	68
Wheat Middlings	89.6	77	30	78	88
Wheat Feed	89.9	77	36	76	87
Rye Feed	88.5	80	..	88	90
Buckwheat Middlings	88.0	87	32	86	83
Oat Feed	93.5	75	42	46	78
Oat Middlings	93.1	80	49	85	93
Corn Gluten Feed	91.3	85	76	88	85
Corn Gluten Meal	90.9	85	55	90	93
Hominy Feed	89.9	66	76	90	91
Brewers' Grains	92.5	81	49	57	89
Dried Beet Pulp	91.8	52	83	83	..

CLASSIFICATION OF SAMPLES.

Commercial feeding stuffs and other fodder materials examined during the past year may be summarized as follows:

Official samples drawn by the Station agent	200
Samples submitted by purchasers or drawn by the Station agent upon request	63
Samples examined in connection with experimental work at the Storrs Station	91
Total	354

INSPECTION OF 1924.

Two hundred official samples were drawn by the Station agent during November and December, 1924. These samples and those

[1] Henry and Morrison: Feeds and Feeding, 18th Ed.

submitted by, or at the request of, purchasers are discussed in this report.

Samples secured for inspection purposes may be classified as follows:

Cottonseed Products	8	Proprietary Horse Feeds	3
Linseed Products	6	" Stock "	21
Wheat Products	38	" Dairy "	37
Rye Products	1	" Hog "	1
Maize Products	17	" Poultry "	38
Brewers' and Distillers' Products	4	Beef Scrap	20
Dried Beet Pulp	6	Total	200

Remarks on Analyses.

(*Analyses in Table II, pages 505-526.*)

Definitions of feeding stuffs here quoted are those adopted by the Association of Feed Control Officials.

COTTONSEED MEAL.

41.12 Per cent. Protein Cottonseed Meal, Choice Quality, must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and must contain at least 41.12 per cent. crude protein, equivalent to 8 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor, or texture, shall be branded Off Quality.

38.56 Per cent. Protein Cottonseed Meal, Prime Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.56 per cent. crude protein, equivalent to 7.5 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

36 Per Cent. Protein Cottonseed Meal, Good Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, free from excess lint and must contain at least 36 per cent. crude protein, equivalent to 7 per cent. of ammonia.

Cottonseed Meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

Seven samples were examined two of which viz., Dixie, **778**, and Neal's Choice, **749**, were deficient by large amounts. Dixie, guaranteed 41.12 per cent. of protein and not over 10 per cent. of fiber was found to contain 33.75 per cent. of protein and 13.88 per cent. of fiber. Analysis of the duplicate which was left with the dealer by our agent, No. **1419**, showed 34.88 per cent. of protein. In the case of Neal's Choice, **749**, the guaranty called for 43 per cent. protein and not more than 10 per cent. of fiber whereas 34.38 per cent. of protein and 13.93 per cent. of fiber were found. This stock was resampled, No. **1361**, and showed a protein content of 33.88 per cent. These deficiencies are unusual; the products were, in fact, cottonseed feeds.

The other samples met the guaranties in all respects.

COTTONSEED FEED.

Cottonseed Feed is a mixture of cottonseed meal and cottonseed hulls containing less than 36 per cent. protein.

One sample, Danish, **728**, fully met the guaranty.

LINSEED MEAL.

Linseed Cake or *Meal* is oil cake or meal made from flaxseed, provided that the final product shall contain less than 6 per cent. of weed seeds and other foreign materials, and provided further that no portion of the stated 6 per cent. of weed seeds and other foreign materials shall be deliberately added.

Old Process Oil Meal, Old Process Linseed Meal is oil meal as defined or linseed meal as defined produced by crushing, cooking and hydraulic pressure.

The six samples examined substantially met or exceeded the guaranties in all respects. The average protein content was 32.57 per cent. which is a little higher than was found a year ago. The prices quoted ranged from $53.00 to $60.00 and averaged $57.67.

WHEAT BRAN.

Wheat Bran is the coarse outer covering of the wheat kernel as separated from cleaned and scoured wheat in the usual process of commercial milling.

Eleven samples were examined all of which satisfied the guaranties for protein and for fat. Fiber guaranties, where given, were not exceeded. The average protein found, 15.71 per cent., exceeded the average guaranteed by about 1.5 per cent., and the average fat content, 5.27 per cent. exceeded the average guaranty by about the same amount.

WHEAT MIDDLINGS.

Standard Middlings consists mostly of fine particles of bran, germ and very little of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual commercial process of milling and shall not contain more than 9.5 per cent. crude fiber.

Flour Middlings shall consist of standard middlings and red dog flour combined in the proportion obtained in the usual process of milling and shall not contain more than 6.0 per cent. crude fiber.

Red Dog Flour consists of a mixture of low-grade flour, fine particles of bran and the fibrous offal from the "tail of the mill" and shall not contain more than 4.0 per cent. crude fiber.

Brown Shorts (*Red Shorts*) consists mostly of the fine particles of bran, germ and very little of the fibrous offal obtained from the "tail of the mill". This product must be obtained in the usual commercial process of milling.

Gray Shorts (*Gray Middlings* or *Total Shorts*) consists of the fine particles of the outer bran, the inner bran or bee-wing bran, the germ and the offal or fibrous materials obtained from the "tail of the mill". This product must be obtained in the usual process of commercial milling.

White Shorts or *White Middlings* consists of a small portion of the fine bran particles and the germ and a large portion of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual process of flour milling.

Sixteen samples were analyzed and all conformed to the guaranties for protein and for fat; fiber guaranties, so far as given, were not exceeded. The fiber content found did not reach 8 per cent. in any case and the average of all samples was but slightly over 6 per cent. The average protein found, 17.1 per cent., exceeds the average guaranty by 1.5 per cent. and the average fat found, 5.50 per cent., exceeded the guaranty by about 1 per cent. The average price quoted was $37.18.

MIXED FEED.

Wheat Mixed Feed (Mill Run Wheat Feed) consists of pure wheat bran and the gray or total shorts or flour middlings combined in the proportions obtained in the usual process of commercial millings.

Of eleven samples of mixed feed no single sample exceeded 8.50 per cent. of fiber while the average for all was 7.23 per cent. The tentative limit of fiber in mixed feed is 8.50 per cent. Protein found exceeded that guaranteed in all cases and there were no deficiencies in fat. The average of prices quoted was $43.55.

RYE PRODUCTS.

Rye Middlings or *Rye Feed* is the by-product obtained from the manufacture of ordinary "100 per cent." rye flour from cleaned and scoured rye grain.

The single sample examined fully met the guaranty.

CORN GLUTEN FEED.

Corn Gluten Feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germs by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

The four samples analyzed fully satisfied their guaranties. The average protein found, 25.11 per cent., exceeded the average guaranty by about 2 per cent. The average of prices quoted was $50.25.

CORN GLUTEN MEAL.

Corn Gluten Meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

One sample was examined. It showed a slight protein deficiency (0.31 per cent.), but the guaranty for fat was exceeded.

HOMINY FEED.

Hominy Feed, Hominy Meal or *Hominy Chop* is the kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial

extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process.

Twelve samples were examined all of which met or exceeded their guaranties for protein and fat and none of which exceeded the limits for fiber. The average of prices quoted was $50.75.

BREWERS' AND DISTILLERS' PRODUCTS.

Brewers' Dried Grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' Dried Grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Four products of this class were examined and all met or exceeded their guaranties.

DRIED BEET PULP.

Dried Beet Pulp is the dried residue from sugar beets which have been cleaned and freed from crowns, leaves and sand, and which have been extracted in the process of manufacturing sugar.

Three samples conformed substantially to the guaranties. The other three, two of which were imported stock, bore no statement of composition. The average of prices quoted was $46.17.

PROPRIETARY MIXED FEEDS.

Horse Feed.

Three samples of horse feeds were analysed all of which conformed to their guaranties.

Dairy Feed.

In this group are included those feeds sold as dairy feeds and dairy rations. Their protein content generally varies between 20 and 25 per cent. with the extreme variation of about 17 to 27 per cent. Fat is guaranteed at from 4 to 6 per cent. and the maximum for fiber is about 10 per cent. The averages for 29 samples examined were protein 22.6, fiber 8.7, and fat 5.4 per cent. Prices quoted varied generally between $50 and $55, range for the extremes being $42 to $59 with an average of about $52.

Of the 29 samples there were only four deficiencies in protein which exceeded 1 per cent.; only three deficiencies in fat were greater than 0.25 per cent. and only one exceeded 0.50 per cent.; and there were no significant excesses of fiber. The protein guaranty of Nobotheration Dairy Ration, **754,** has been revised in view of the deficiency found.

Stock Feed.

Feeds of this class contain from 8 to 12 per cent. of protein. The average protein found in the 19 samples examined was about 10 per cent. No deficiencies in protein were found. There was one excess of fiber and four fat deficiencies, three of which were more than 0.5 per cent. In all nineteen samples were analyzed. The formula for Nobotheration Stock Feed, **762,** we are advised has been changed to meet the fat deficiency shown. New tags were furnished the dealer by the manufacturers of Pennant Stock Feed to revise the fat guaranty.

Hog Feed and Calf Feed.

One hog feed and two calf feeds were analyzed. All substantially met their guaranties.

Poultry Feeds.

Fifty-eight samples of poultry feeds, twenty of which were meat scraps, were analyzed. Of the poultry feeds there were only three shortages in protein and only one, **845,** which exceeded 1 per cent. Fiber guaranties so far as they were given, were exceeded in only one sample and there were no deficiencies in fat.

Among the samples of beef scrap there were three deficiencies in protein only two of which, **871** and **852**, were considerable. There were no shortages in fat; generally the guaranty for fat was largely exceeded.

SUMMARY OF DEFICIENCIES.

In Table III are summarized deficiencies as shown by the inspection this year. Shortages in protein of less than one per cent. and in fat of less than one-fourth of one per cent., and excesses in fiber of less than one per cent. are not included. It shows that of the two hundred samples examined eighteen, or 9 per cent., have failed to meet guaranties in one or more particulars. The law prohibiting the use of wire in affixing tags has been violated in three instances.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	OIL SEED PRODUCTS.							
	Cottonseed Meal.							
737	Paramount. Ashcraft-Wilkinson Co.,	*Hazardville:* Amos D. Bridges Sons	6.50	5.79	36.00	12.95	30.56	8.20
	Atlanta, Ga.	Guaranty	....	....	36.00	14.00	....	5.50
868[1]	Steerboy. S. P. Davis, Little Rock,	*New Milford:* Geo. T. Soule	5.95	7.52	43.25	5.88	29.10	8.30
	Ark.	Guaranty	....	....	43.00	10.00	....	6.00
775	Bull. Humphreys-Godwin Co., Memphis, Tenn.	*Norwich:* Norwich Grain Co.	5.55	5.39	44.88	9.60	27.55	7.03
		Guaranty	....	....	43.00	10.00	....	5.00
778	Dixie. Humphreys-Godwin Co., Memphis, Tenn.	*Norwich:* Yantic Grain & Products Co.	6.70	5.89	33.75	13.88	33.00	6.78
		Guaranty	....	....	41.12	10.00	....	5.00
821	Lovit. L. B. Lovitt & Co., Memphis,	*Granby:* E. H. Rollins	6.20	6.15	41.19	9.98	27.78	8.70
	Tenn.	Guaranty	....	....	41.00	10.00	....	6.00
749	"Neal's Choice." L. B. Lovitt & Co.,	*Guilford:* Fred C. Morse	7.48	5.47	34.38	13.93	32.69	6.05
	Memphis, Tenn.	Guaranty	....	....	43.00	10.00	....	6.00
713	"Thirty Six Brand". L. B. Lovitt & Co.,	*Plantsville:* C. A. Cowles	6.83	5.72	37.00	12.55	31.05	6.85
	Memphis, Tenn.	Guaranty	....	....	36.00	14.00	....	5.00
		Average of guaranty	....	....	***40.45***	***11.14***	....	***5.50***
		Average of analyses	**6.46**	**5.99**	**38.64**	**11.30**	**30.19**	**7.42**
		Average digestible	....	....	**32.5**	**4.2**	**22.7**	**7.0**
	Cottonseed Feed.							
728	Danish. Humphreys-Godwin Co.,	*Thompsonville:* Geo. S. Phelps	8.18	6.14	37.00	12.85	29.48	6.35
	Memphis, Tenn.	Guaranty	....	....	36.00	15.00	....	5.00

[1] Wire tags.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	OIL SEED PRODUCTS—*Concluded.*							
	Linseed Meal, Old Process.							
710	Alinco. American Linseed Co., N.Y.	*Plantsville:* C. A. Cowles	7.58	6.08	31.44	7.90	38.55	8.45
		Guaranty	....	....	32.00	....	....	5.00
739	Amco. American Milling Co., Peoria, Ill.	*Hazardville:* Amos D. Bridges' Sons	9.80	5.64	31.25	9.20	37.61	6.50
		Guaranty	....	....	30.00	....	....	5.00
872	Pure. Archer-Daniels Midland Co., Minneapolis, Minn.	*New Milford:* Geo. E. Ackley Co.	9.15	4.72	35.50	7.73	36.57	6.33
		Guaranty	....	....	34.00	....	....	6.00
864	Pure. Kellogg & Miller, Amsterdam, N. Y.	*Waterbury:* Spencer Grain Co.	7.65	5.67	31.63	7.55	40.40	7.10
		Guaranty	....	....	32.00	....	....	4.70
724	Kelloggs. Spencer Kellogg Co., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps	8.70	5.26	34.94	8.23	36.52	6.35
		Guaranty	....	....	34.00	....	....	5.00
822	Argentine. Mann Bros. Co., Buffalo, N. Y.	*Granby:* E. H. Rollins	9.85	5.74	30.63	7.70	39.13	6.95
		Guaranty	....	....	31.00	10.00	....	6.00
		Average guaranty	....	....	**32.17**	**10.00**	....	**5.28**
		Average of analyses	**8.79**	**5.52**	**32.57**	**8.05**	**38.12**	**6.95**
		Average digestible	....	....	**29.0**	**4.6**	**29.7**	**6.2**
	WHEAT PRODUCTS.							
	Wheat Bran.							
722	Dominion Flour Mills Co., Montreal, Canada	*New Britain:* Stanley Svea Grain & Coal Co.	9.13	5.70	16.00	9.10	54.59	5.48
		Guaranty	....	....	15.00	....	....	3.50

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Continued.*							
	Wheat Bran—Concluded.							
817[2]	Wm. Hamilton & Son, Inc., Honeoye Falls, N. Y.	*Derby:* Peterson-Hendee Co.	9.63	6.29	15.00	8.25	56.45	4.38
		Guaranty	....	....	13.25	11.60	....	2.90
708[2]	Choice. Hecker-Jones-Jewell Milling Co., New York City	*Plantsville:* C. A. Cowles	9.30	6.42	15.06	9.70	54.12	5.40
		Guaranty	....	....	13.00	14.00	....	3.50
794	Lakewood's. Lake of the Woods Milling Co., Montreal, Canada	*Willimantic:* Boston Grain Co.	8.90	5.68	14.38	10.60	54.99	5.45
		Guaranty	....	....	15.00	....	....	3.50
699	Niagara. Niagara Falls Milling Co., Niagara Falls, N. Y.	*Meriden:* H. Grulick	9.78	6.54	16.25	9.50	52.55	5.38
		Guaranty	....	....	15.00	....	....	3.50
800	Northwestern Consolidated Milling Co., Minneapolis, Minn.	*Stafford Springs:* Stafford Granary	9.85	6.26	16.13	9.20	53.53	5.03
		Guaranty	....	....	13.00	....	....	4.00
702[2]	Pillsbury's. Pillsbury Flour Mills, Buffalo, N. Y.	*West Cheshire:* G. W. Thorpe	10.00	6.21	15.38	10.15	52.63	5.63
		Guaranty	....	....	14.00	....	....	4.00
764	Golden Loaf. Tennant & Hoyt Co., Lake City, Minn.	*Yantic:* Yantic Grain & Products Co.	9.65	5.64	15.88	8.55	55.00	5.28
		Guaranty	....	....	14.00	....	....	4.00
854	Eagle. Vannatter & Ham, Ltd., Toronto, Canada	*Branford:* S. V. Osborn	8.83	5.75	15.81	8.93	54.95	5.73
		Guaranty	....	....	15.00	11.00	....	4.00
736[2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn.	*Hazardville:* Amos D. Bridges' Sons	10.10	5.86	15.88	8.78	54.05	5.33
		Guaranty	....	....	14.00	....	....	4.00
741[2]	The Wilson Flour Mills, Wilson, Kansas	*Rockville:* Rockville Grain & Coal Co.	9.30	6.81	17.00	10.08	51.91	4.90
		Guaranty	....	....	14.50	11.00	....	3.50
		Average guaranty	....	....	**14.16**	**11.90**	....	**3.67**
		Average of analyses	**9.50**	**6.11**	**15.71**	**9.35**	**54.06**	**5.27**
		Average digestible	....	....	**12.3**	**2.9**	**38.9**	**3.6**

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Continued.*							
	Wheat Middlings.							
753	Central Milling Co., Wilson, N. Y.	*New London:* P. Schwartz Co.	9.95	3.58	17.75	4.68	58.29	5.75
		Guaranty	....	....	15.00	....	....	3.50
748	Dominion Flour Mills, Montreal, Canada	*Guilford:* Fred C. Morse	9.63	4.33	17.56	6.95	55.20	6.33
		Guaranty	....	....	16.00	....	....	5.00
712[2]	The Fairchild Milling Co., Cleveland, Ohio	*Plantsville:* C. A. Cowles	10.95	3.14	15.63	4.48	61.55	4.25
		Guaranty	....	....	15.00	8.00	....	3.50
694	Jas. Goldie Co., Ltd., Toronto, Ontario	*Wallingford:* A. E. Hall	10.58	4.60	17.50	7.53	53.69	6.10
		Guaranty	....	....	17.00	8.00	....	6.00
863[2]	H. Hecker-Jones-Jewell Milling Co., New York City	*Waterbury:* Spencer Grain Co.	9.65	4.96	16.38	7.60	56.41	5.00
		Guaranty	....	....	14.00	9.50	....	5.00
833	Lakewood's. Lake of the Woods Milling Co., Montreal, Canada	*Southport:* C. Buckingham & Co.	10.88	3.97	16.88	5.65	56.72	5.90
		Guaranty	....	....	16.00	....	....	5.00
795[2]	Rex. Maple Leaf Milling Co., Toronto, Canada	*Willimantic:* Willimantic Grain Co.	8.78	4.25	17.38	6.90	56.96	5.73
		Guaranty	....	....	16.00	....	....	5.00
816[2]	Niagara. Niagara Falls Milling Co., Niagara Falls, N. Y.	*Derby:* Peterson-Hendee Co.	9.80	5.32	17.75	7.10	54.35	5.68
		Guaranty	....	....	15.50	....	....	4.00
745[2]	Ogilvie Flour Mills, Fort William, Canada	*Rockville:* Rockville Grain & Coal Co.	8.48	3.56	17.00	7.08	58.68	5.20
		Guaranty	....	....	15.00	....	....	4.00
686[2]	Pillsbury's. Pillsbury Flour Mills, Buffalo, N. Y.	*Hamden:* I. W. Beers	11.05	3.05	17.25	3.50	60.25	4.90
		Guaranty	....	....	15.00	....	....	4.00

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1921.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Continued.*							
	Wheat Middlings—Concluded.							
865	Pillsbury's XXX Daisy. Pillsbury Mills, Minneapolis, Minn.	*Danbury:* H. E. Meeker	10.35	2.39	17.69	1.40	63.77	4.40
		Guaranty	....	....	16.00	....	....	4.00
752 [2]	Bell Cow. Quaker Oats Co., Saskatoon, Canada	New London: P. Schwartz Co.	10.65	4.24	17.38	6.10	55.38	6.25
		Guaranty	....	....	16.00	8.00	....	4.00
811	Red Wing. Red Wing Milling Co., Red Wing, Minn.	*Middletown:* Meech & Stoddard, Inc.	8.85	5.16	17.38	7.70	55.46	5.45
		Guaranty	....	....	15.00	....	....	5.10
819 [2]	Black Hawk. Robin Hood Mills, Calgary, Canada	*Ansonia:* Ansonia Flour & Grain Co.	8.80	4.09	17.00	7.10	57.56	5.45
		Guaranty	....	....	17.00	....	....	4.50
750 [2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn.	*New London:* New London Grain Co.	10.45	4.77	16.56	7.25	55.07	5.90
		Guaranty	....	....	15.00	....	....	4.00
799 [2]	Pioneer. Western Canada Flour Mills, Winnipeg, Canada	*So. Coventry:* E. W. Latimer	10.50	4.03	17.19	6.08	56.50	5.70
		Guaranty	....	....	16.00	....	....	4.50
		Average guaranty	....	....	**15.59**	**8.38**	....	**4.44**
		Average of analyses	**9.96**	**4.09**	**17.14**	**6.07**	**57.24**	**5.50**
		Average digestible	....	....	**13.2**	**1.8**	**44.6**	**4.8**
	Wheat Feed (Mixed Feed)							
866	Wingold. Bay State Milling Co., Winona, Minn.	*Danbury:* F. C. Benjamin	10.40	4.54	17.13	5.55	57.45	4.93
		Guaranty	....	....	15.60	....	....	4.10
744	Boston. Duluth Superior Milling Co., Duluth, Minn.	*Rockville:* Rockville Grain & Coal Co.	8.48	5.27	16.50	8.40	55.62	5.73
		Guaranty	....	....	15.00	....	....	4.00
788	Durum. Duluth Superior Milling Co., Duluth, Minn.	*Putnam:* F. M. Cole	8.38	4.48	16.75	8.50	56.61	5.28
		Guaranty	....	....	15.00	....	....	5.00

[2] With screenings

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Concluded.*							
	Wheat Feed (Mixed Feed)—Concluded.							
882	Boston. Duluth Superior Milling Co., Duluth, Minn	*Bloomfield:* Bloomfield Farmers' Exchg	9.65	5.23	16.00	7.95	55.69	5.48
		Guaranty	....	....	15.00	....	....	4.00
707	Gold Mine. H. H. King Flour Mills, Minneapolis, Minn	*Plantsville:* C. A. Cowles	8.98	5.05	16.25	7.85	56.29	5.58
		Guaranty	....	....	15.00	....	....	4.50
805	Redwing. Meech & Stoddard, Middletown, Conn	*Hartford:* Meech Grain Co	9.30	5.14	16.75	7.68	55.70	5.43
		Guaranty	....	....	15.00	....	....	4.50
826	Pennant Quality. National Milling Co., Toledo, Ohio	*Farmington:* Winchell Smith Grist Mill	8.38	3.97	16.38	7.13	58.54	5.60
		Guaranty	....	....	15.00	....	....	3.75
823[2]	Pillsbury's. Pillsbury Mills, Minneapolis, Minn	*Granby:* E. H. Rollins	10.10	4.17	17.88	5.90	57.17	4.78
		Guaranty	....	....	15.00	....	....	4.00
733	Occident. Russell Miller Milling Co., Minneapolis, Minn	*Suffield:* Spencer Bros	9.78	5.09	16.69	7.25	55.29	5.90
		Guaranty	....	....	15.50	....	....	4.50
786[2]	Dakota. State Mill & Elevator Co., Grand Forks, No. Dakota	*Danielson:* Dayville Grain & Coal Co	7.78	5.13	16.31	8.03	56.87	5.88
		Guaranty	....	....	15.10	....	....	5.30
874[2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn	*Torrington:* F. L. Wadhams & Sons	10.35	4.25	15.38	5.33	60.31	4.38
		Guaranty	....	....	16.00	....	....	4.00
		Average guaranty	....	....	**15.20**	....	....	**4.33**
		Average of analyses	**9.23**	**4.76**	**16.55**	**7.23**	**56.87**	**5.36**
		Average digestible	....	....	**12.7**	**2.6**	**43.2**	**4.7**

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	RYE PRODUCTS.							
810[2]	Feed. Boutwell Milling & Grain Co., Troy, N. Y.	*Middletown:* Meech & Stoddard, Inc.	10.85	3.69	14.38	4.45	63.43	3.20
		Guaranty	....	....	13.00	....	....	3.00
	MAIZE PRODUCTS.							
	Corn Gluten Feed.							
880	American Maize Products Co., New York City	*Bloomfield:* Bloomfield Farmers' Exchg.	7.90	4.18	24.50	6.33	54.44	2.65
		Guaranty	....	....	23.00	....	....	1.50
855	Buffalo. Corn Products Refining Co., New York City	*Branford:* S. V. Osborn	9.25	5.32	24.50	6.35	51.48	3.10
		Guaranty	....	....	23.00	....	....	2.00
751	Douglas. Penick & Ford Ltd., Cedar Rapids, Iowa	*New London:* P. Schwartz Co.	8.15	7.07	28.13	7.43	46.24	2.98
		Guaranty	....	....	23.00	....	....	1.00
704	Staley's. A. E. Staley Mfg. Co., Decatur, Ill	*West Cheshire:* G. W. Thorpe	8.38	4.44	23.31	6.58	54.29	3.00
		Guaranty	....	....	23.00	....	....	1.00
		Average guaranty	....	....	**23.00**	....	....	**1.38**
		Average of analyses	**8.42**	**5.25**	**25.11**	**6.67**	**51.62**	**2.93**
		Average digestible	....	....	**21.3**	**5.1**	**45.4**	**2.5**
	Corn Gluten Meal.							
777	Diamond. Corn Products Refining Co., New York City	*Norwich:* Yantic Grain & Products Co.	7.93	1.35	39.69	2.98	44.85	3.20
		Guaranty	....	....	40.00	....	....	1.00

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	MAIZE PRODUCTS—*Continued.*							
	Hominy Feed.							
757	Aunt Jemima Mills Co., St. Joseph, Mo.	*Mystic:* Yantic Grain Co.	9.70	2.62	11.13	5.15	60.37	11.03
		Guaranty	....	....	10.00	....	....	5.00
721	Paragon. C. M. Cox, Boston, Mass.	*Bristol:* Bristol Grain & Supply Co.	9.30	3.45	11.13	4.68	63.84	7.60
		Guaranty	....	....	10.00	7.00	....	6.00
884	Ideal. Elevator Milling Co., Springfield, Mass.	*Seymour:* Seymour Grain & Coal Co.	8.78	3.25	11.88	4.88	62.73	8.48
		Guaranty	....	....	10.00	6.00	....	7.00
837	Emco. Evans Milling Co., Indianapolis, Ind.	*Norwalk:* Francis H. Leggett & Co.	10.13	2.57	11.00	3.85	66.15	6.30
		Guaranty	....	....	10.00	7.00	....	5.00
695	B.C. Kellogg Company, Battle Creek, Mich.	*Wallingford:* A. E. Hall	9.73	2.66	11.25	4.70	64.58	7.08
		Guaranty	....	....	10.00	5.00	....	6.00
783	Sonny South. Louisville Milling Co., Louisville, Ky.	*Moosup:* T. E. Main & Sons Co.	8.13	2.53	11.06	4.68	65.65	7.95
		Guaranty	....	....	10.00	6.00	....	7.00
742	Bufceco. Maple Flake Mills, Chicago, Ill.	*Rockville:* Rockville Grain & Coal Co.	10.05	2.58	11.00	3.63	67.59	5.15
		Guaranty	....	....	10.00	6.00	....	5.00
720	Choice Steam Cooked. Miner-Hillard Milling Co., Wilkes-Barre, Pa.	*Bristol:* Bristol Grain & Supply Co.	9.25	2.36	10.50	4.05	69.36	4.48
		Guaranty	....	....	10.00	5.00	....	4.00
779	Mystic. Mystic Mills, Sioux City, Iowa	*Norwich:* Yantic Grain & Products Co.	9.05	2.22	10.94	4.60	66.36	6.83
		Guaranty	....	....	8.50	5.00	....	4.00
701[1]	The Patent Cereals Co., Geneva, N. Y.	*Meriden:* H. Grulich	10.35	2.68	11.00	4.70	65.54	5.73
		Guaranty	....	....	10.00	5.00	....	5.00

[1] Wire tags.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	MAIZE PRODUCTS—*Concluded.*							
	Hominy Feed—Concluded.							
688	Burt's. Postum Cereal Co., Inc., Battle Creek, Mich	*Hamden:* I. W. Beers	10.40	2.57	11.25	4.08	65.42	6.28
		Guaranty	....	....	10.00	....	....	6.00
725	Yellow. Quaker Oats Co., Chicago, Ill.	*Thompsonville:* Geo. S. Phelps	9.20	2.34	10.63	4.28	68.12	5.43
		Guaranty	....	....	10.50	....	....	5.00
		Average guaranty	....	....	**9.92**	**5.78**	....	**5.42**
		Average of analyses	**9.51**	**2.65**	**11.06**	**4.44**	**65.48**	**6.86**
		Average digestible	....	....	**7.3**	**3.4**	**58.9**	**6.2**
	BREWERS' AND DISTILLERS' PRODUCTS.							
867	Dried Brewers' Grains. Atlantic Export Co., New York City	*New Milford:* Geo. T. Soule	5.40	3.49	25.00	13.33	45.28	7.50
		Guaranty	....	....	25.00	14.00	....	6.00
781	Corn Distillers' Grain. Canada Industrial Alcohol Co., Corbyville, Ont	*Norwich:* Yantic Grain & Products Co.	3.18	2.67	31.31	10.48	41.51	10.85
		Guaranty	....	....	30.00	....	....	3.00
738	Brewers' Dried Grains. St. Albans Grain Co., St. Albans, Vt.	*Hazardville:* Amos D. Bridges' Sons	6.70	3.56	23.19	13.10	45.95	7.50
		Guaranty	....	....	21.00	16.00	....	5.00
714	Ricomalt. Waterloo Distilling Co., Waterloo, N. Y.	*Plantsville:* C. A. Cowles	4.20	3.60	31.00	9.68	39.59	11.93
		Guaranty	....	....	28.00	....	....	10.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	DRIED BEET PULP.							
842	Dutch Dried. Chr. de Vries, Rotterdam	*Stamford:* Francis H. Leggett & Co.	6.88	4.74	7.75	17.73	61.92	0.98
		Guaranty	....	....	....	....	....	....
698	The Larrowe Milling Co., Detroit, Mich	*Wallingford:* A. E. Hall	10.40	2.74	8.25	17.63	60.18	0.80
		Guaranty	....	....	8.00	20.00	....	0.50
877	Martiners Grain Co., New York City	*Winsted:* E. Manchester & Sons	7.05	3.35	8.94	18.20	61.48	0.98
		Guaranty	....	....	....	....	....	....
719	Michigan Sugar Co., Saginaw, Mich	*Plainville:* W. S. Eaton	6.43	3.04	8.38	18.95	62.50	0.70
		Guaranty	....	....	8.00	20.00	....	0.50
771	The Scholl Co., Newark, N. J.	*Colchester:* Meech & Brown Grain Co.	7.10	3.53	9.13	20.25	58.84	1.15
		Guaranty	....	....	7.00	20.00	....	0.25
692	Manufacturer Unknown	*North Haven:* W. L. Thorpe	8.58	3.22	9.13	19.78	57.79	1.50
		Guaranty	....	....	....	....	....	....
		Average guaranty	....	....	**7.67**	**20.00**	....	**0.42**
		Average of analyses	**7.74**	**3.44**	**8.60**	**18.76**	**60.44**	**1.02**
		Average digestible	....	....	**4.5**	**15.6**	**50.2**	....
	PROPRIETARY MIXED FEEDS.							
	Horse Feed.							
808	Diamond. Dwight Hamlin, Pittsburgh, Pa.	*Hartford:* Meech Grain Co.	7.50	5.56	8.88	9.00	65.43	3.63
		Guaranty	....	....	9.00	....	....	1.50

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Horse Feed—Concluded.							
807	Imperial Steam Cooked. Imperial Grain & Milling Co., Toledo, Ohio	*Hartford:* Meech Grain Co.	8.98	2.47	9.88	5.83	67.99	4.85
		Guaranty	....	....	9.50	....	....	4.00
726	Schumacher Sugared Feed. Quaker Oats Co., Chicago, Ill.	*Thompsonville:* Geo. S. Phelps	9.15	5.20	10.19	10.63	60.68	4.15
		Guaranty	....	....	10.00	....	....	3.25
		Average guaranty	....	....	**9.50**	....	....	**2.92**
		Average of analyses	**8.54**	**4.41**	**9.65**	**8.49**	**64.70**	**4.21**
	Dairy Feed.							
802	Advanced Registry. Arcady Farms Milling Co., Chicago, Ill.	*Stafford Springs:* Dennis Grain Mill	8.08	4.88	25.56	9.70	45.73	6.05
		Guaranty	....	....	25.00	....	....	5.00
803	Peerless. Arcady Farms Milling Co., Chicago, Ill.	*Stafford Springs:* Dennis Grain Mill	7.35	7.16	21.25	12.45	46.46	5.33
		Guaranty	....	....	20.00	....	....	4.00
801	Wonder Dairy Feed. Arcady Farms Milling Co., Chicago, Ill.	*Stafford Springs:* Dennis Grain Mill	8.63	5.38	24.25	9.65	46.84	5.25
		Guaranty	....	....	24.00	....	....	5.00
735	Success Dairy Ration. Amos D. Bridges' Sons, Hazardville, Conn.	*Hazardville:* Amos D. Bridges' Sons	8.90	4.44	21.38	8.70	51.15	5.43
		Guaranty	....	....	20.00	....	....	5.20
754	Nobotheration Dairy Ration. C. W. Campbell Co., Westerly, R. I.	*Mystic:* J. L. Manning	9.95	4.17	20.44	5.90	54.76	4.78
		Guaranty	....	....	22.00	....	....	5.00
706	Unicorn Dairy Ration. Chapin & Co., Chicago, Ill.	*West Cheshire:* G. W. Thorpe	8.05	6.31	24.25	8.58	46.93	5.88
		Guaranty	....	....	24.00	10.00	....	5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Continued.							
706	Dairy Ration. C. A. Cowles, Plantsville, Conn.	*Plantsville:* C. A. Cowles	8.13	6.35	27.13	8.33	43.58	6.48
		Guaranty	....	....	24.00	....	....	5.00
691	Wirthmore Balanced Ration. C. M. Cox Co., Boston, Mass.	*North Haven:* W. L. Thorpe	9.25	6.39	25.38	8.90	43.85	6.23
		Guaranty	....	....	25.00	....	....	5.50
785	Wirthmore Dairy Feed. C. M. Cox Co., Boston, Mass.	*Danielson:* Quinebaug Mills	8.85	4.05	22.25	7.00	54.07	3.78
		Guaranty	....	....	20.00	....	....	5.00
847	Basic Dairy Ration. R. G. Davis & Sons, New Haven, Conn.	*Glenbrook:* Davis-Scofield Co.	9.98	5.83	20.00	7.68	51.68	4.83
		Guaranty	....	....	20.00	....	....	5.00
873	Litchfield Dairy Ration. R. G. Davis & Sons, New Haven, Conn.	*Torrington:* Litchfield Coop. Assoc.	8.93	5.98	20.06	8.23	51.85	4.95
		Guaranty	....	....	20.00	9.00	....	5.00
730	Fulpail Dairy Ration. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.28	7.20	21.00	9.23	48.06	5.23
		Guaranty	....	....	20.00	9.00	....	4.00
729	Milkmore Dairy Ration. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.08	6.05	24.88	8.73	45.13	6.13
		Guaranty	....	....	24.00	9.00	....	4.00
709	Elmore Milk Grains. Elmore Milling Co., Oneonta, N. Y.	*Plantsville:* C. A. Cowles	8.10	6.35	25.56	8.40	46.06	5.53
		Guaranty	....	....	25.00	11.00	....	6.00
697	Lancaster 20% Dairy Feed. John W. Eshelman & Sons, Lancaster, Pa.	*Wallingford:* A. E. Hall	9.93	6.75	19.25	10.40	49.54	4.13
		Guaranty	....	....	20.00	....	....	4.00
787	Advance Dairy Feed. Grain Marketing Co., Chicago, Ill.	*Danielson:* Dayville Grain & Coal Co.	8.98	7.93	17.31	10.05	49.53	6.20
		Guaranty	....	....	16.00	....	....	5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Continued.							
774	Grandin's 24% Balanced Dairy Ration. D. H. Grandin Mill Co., Jamestown, N. Y.	*Norwich:* Norwich Grain Co.	8.63	5.25	23.00	8.23	49.81	5.08
		Guaranty	....	....	24.00	....	....	5.00
796	Grandin's Twin Six Dairy Feed. D. H. Grandin's Mill Co., Jamestown, N.Y.	*Willimantic:* Willimantic Grain Co.	9.08	5.82	21.75	7.68	50.57	5.10
		Guaranty	....	....	22.00	....	....	5.00
839	Algrane Milk Feed. The H-O Cereal Co., Inc., Buffalo, N. Y.	*So. Norwalk:* Roodner Feed Co.	8.58	5.57	17.13	10.88	54.01	3.83
		Guaranty	....	....	16.00	15.00	....	4.00
746	Beatsall Milk Grains. Kasco Mills, Waverly, N. Y.	*Guilford:* Fred C. Morse	8.85	6.16	24.38	8.03	47.03	5.55
		Guaranty	....	....	22.00	....	....	4.50
747	Kasco Mormilk Dairy Ration. Kasco Mills, Waverly, N. Y.	*Guilford:* Fred C. Morse	8.40	5.40	27.06	8.18	44.98	5.98
		Guaranty	....	....	25.00	....	....	5.00
711	Larro Feed Ready Ration. Larrowe Milling Co., Detroit, Mich.	*Plantsville:* C. A. Cowles	8.63	5.76	21.00	10.98	49.08	4.55
		Guaranty	....	....	20.00	....	....	4.00
838	Nabob Dairy Feed. Francis H. Leggett & Co., Stamford, Conn.	*Norwalk:* Francis H. Leggett & Co.	8.85	8.09	19.56	9.55	49.60	4.35
		Guaranty	....	....	20.00	....	....	4.00
875	Red Star Dairy Feed. E. Manchester & Sons, Winsted, Conn.	*Winsted:* E. Manchester & Sons	8.10	5.70	22.75	7.03	49.87	6.55
		Guaranty	....	....	23.00	....	....	4.00
743	Bull Brand Dairy Ration. Maritime Milling Co., Buffalo, N. Y.	*Rockville:* Rockville Grain & Coal Co.	9.23	6.53	22.50	10.48	45.01	6.25
		Guaranty	....	....	24.00	....	....	6.00
768	Red Wing Junior Dairy Ration. Meech & Stoddard, Inc., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co.	8.18	5.47	19.25	7.75	53.92	5.43
		Guaranty	....	....	20.00	....	....	5.00
769	Red Wing Special Dairy Ration. Meech & Stoddard, Inc., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co.	7.90	4.84	23.38	7.75	49.73	6.40
		Guaranty	....	....	24.00	....	....	6.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
			Pounds per Hundred					
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Concluded.							
789	Oswego 20% Dairy Feed. Ontanio Milling Co., Oswego, N. Y.	*Putnam:* Bosworth Bros.	7.70	5.52	20.13	10.98	50.09	5.58
		Guaranty	....	....	20.00	....	....	5.00
766	Uncle John's 24% Cream Pot Ration. Ontanio Milling Co., Oswego, N. Y.	*Colchester:* David Shea	8.05	5.80	21.63	7.45	51.14	5.93
		Guaranty	....	....	24.00	....	....	5.50
862	Stevens 44 Sweetened Dairy Ration. Park & Pollard Co., Boston, Mass.	*Waterbury:* Spencer Grain Co.	8.85	7.68	23.38	7.83	47.33	4.93
		Guaranty	....	....	24.00	....	....	5.00
687	Pillsbury's 24% Dairy Feed. Pillsbury Flour Mills Co., Minneapolis, Minn.	*Hamden:* I. W. Beers	9.50	7.68	22.81	8.70	45.71	5.60
		Guaranty	....	....	24.00	....	....	4.50
827	Burt's Dairy Feed. Postum Cereal Co., Battle Creek, Mich.	*Farmington:* Winchell Smith Grist Mill	7.70	4.58	24.06	6.85	51.78	5.03
		Guaranty	....	....	24.00	....	....	5.00
814	Purina 24% Cow Chow Feed. Ralston Purina Co., St. Louis, Mo.	*Middletown:* H. G. Wadhams	9.73	6.12	25.94	10.68	42.65	4.88
		Guaranty	....	....	24.00	....	....	4.30
634	Red Brand Dairy Feed. Tioga Mill & Elevator Co., Waverly, N. Y.	*Southport:* C. Buckingham & Co.	8.98	7.00	25.69	8.13	44.42	5.78
		Guaranty	....	....	24.00	10.00	....	4.50
825	Mill Streams Boomerang Dairy Feed. Winchell Smith Grist Mill, Farmington, Conn.	*Farmington:* Winchell Smith Grist Mill	8.98	5.53	24.19	6.03	49.54	5.73
		Guaranty	....	....	24.00	....	....	6.00
758	Big Y Dairy Ration. Yantic Grain & Products Co., Norwich, Conn.	*Mystic:* Yantic Grain Co.	9.03	4.35	26.63	7.28	47.31	5.40
		Guaranty	....	....	25.00	10.00	....	5.00
759	Uncas Dairy Feed. Yantic Grain & Products Co., Norwich, Conn.	*Mystic:* Yantic Grain Co.	8.43	5.18	20.00	8.65	51.81	5.93
		Guaranty	....	....	20.00	....	....	5.00
		Average guaranty	....	....	**22.22**	**10.38**	....	**4.86**
		Average of analyses	**8.73**	**5.93**	**22.60**	**8.68**	**48.65**	**5.41**

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Stock Feed.							
797	Pennant Brand Stock Feed. E. W. Bailey & Co., Swanton, Vt	*So. Coventry:* E. W. Latimer	8.35	4.10	10.38	9.95	61.50	5.63
		Guaranty	....	....	10.00	10.00	....	6.50
790	Parex Stock Feed. Bosworth Bros., Putnam, Conn	*Putnam:* Bosworth Bros	7.88	4.64	9.25	10.60	63.18	4.45
		Guaranty	....	....	9.00	....	....	3.00
762	Nobotheration Stock Feed. C. W. Campbell Co., Westerly, R. I	*Westerly:* C. W. Campbell Co	9.18	3.70	13.13	7.45	62.81	3.73
		Guaranty	....	....	10.00	....	....	5.00
767	Fortune Stock Feed. Coles Co., Middletown, Conn	*Colchester:* David Shea	7.50	3.75	9.25	11.28	63.27	4.95
		Guaranty	....	....	9.00	11.00	....	5.00
784	Charlestock Feed. C. M. Cox Co., Boston, Mass	*Danielson:* Quinebaug Mills	7.50	5.70	10.94	12.63	57.45	5.78
		Guaranty	....	....	9.00	14.00	....	4.00
734	Wirthmore Stock Feed. C. M. Cox Co., Boston, Mass	*Suffield:* Spencer Bros	8.78	3.78	10.13	9.13	61.63	6.55
		Guaranty	....	....	9.00	....	....	4.00
848	Davis Stock Feed. R. G. Davis & Sons, New Haven, Conn	*Glenbrook:* Davis-Scofield Co	9.43	4.47	10.63	12.48	60.16	2.83
		Guaranty	....	....	10.50	....	....	4.00
715	Flory's Special Stock Feed. Flory Milling Co., Bangor, Penn	*Plantsville:* C. A. Cowles	7.03	4.97	8.75	15.24	60.53	3.48
		Guaranty	....	....	8.00	14.00	....	3.00
772	Grandin's Stock Feed. D. H. Grandin Mill Co., Jamestown, N. Y	*Norwich:* Norwich Grain Co	7.80	3.50	9.13	9.18	65.49	4.90
		Guaranty	....	....	9.00	....	....	5.00
755	New England Stock Feed. H-O Cereal Co., Buffalo, N. Y	*Mystic:* J. L. Manning	8.25	4.45	12.00	9.80	61.07	4.43
		Guaranty	....	....	9.50	....	....	4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Stock Feed—Concluded.							
835	Nabob Stock Feed. Francis H. Leggett & Co., Norwalk, Conn.	*Norwalk:* Francis H. Leggett & Co.	9.10	4.40	10.38	11.75	61.79	2.58
		Guaranty	....	....	10.00	....	....	3.00
770	Red Wing Stock Feed. Meech & Stoddard Co., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co.	7.95	3.71	10.25	10.03	63.51	4.55
		Guaranty	....	....	9.00	....	....	3.00
727	Fidelity Stock Feed. Nowak Milling Corp., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps	7.98	5.06	8.56	11.93	63.02	3.45
		Guaranty	....	....	8.00	....	....	3.00
791	Park & Pollard Co. Stock Feed. Park & Pollard Co., Boston, Mass.	*Putnam:* Bosworth Bros.	8.73	7.21	9.94	7.25	61.74	5.13
		Guaranty	....	....	8.00	....	....	2.50
553	Burt's Stock Feed. Postum Cereal Co., Inc., Battle Creek, Mich.	*Branford:* S. V. Osborn	9.10	3.90	9.44	8.03	64.60	4.93
		Guaranty	....	....	9.00	9.50	....	4.00
830	Schumacker Feed. Quaker Oats Co., Chicago, Ill.	*Stratford:* Z. C. Ingersoll	7.98	4.74	10.75	10.88	62.05	3.60
		Guaranty	....	....	10.00	....	....	3.25
831	White Star Stock Feed. Quaker Oats Co., Chicago, Ill.	*Bridgeport:* Samp Mortar Mills	8.65	4.27	8.13	12.63	63.29	3.03
		Guaranty	....	....	9.00	....	....	3.00
718	Syragold Stock Feed. Syracuse Milling Co., Syracuse, N. Y.	*Plainville:* W. S. Eaton	9.13	4.44	9.13	11.23	62.72	3.35
		Guaranty	....	....	9.00	....	....	3.00
793	Red Tag Big Y Stock Feed. Yantic Grain & Products Co., Norwich, Conn.	*Willimantic:* Boston Grain Co.	8.10	4.35	12.00	10.45	59.92	5.18
		Guaranty	....	....	9.00	....	....	4.00
		Average guaranty	....	....	**9.16**	**11.70**	....	**3.80**
		Average of analyses	**8.34**	**4.48**	**10.11**	**10.63**	**62.10**	**4.34**

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Hog Feed, Etc.							
400	Purina Pig Chow. Purina Mills, St. Louis, Mo	*Meriden:* H. Grulich	9.83	8.56	21.50	7.05	48.13	4.93
		Guaranty	....	....	20.00	....	....	3.20
815	Purina Calf Chow. Purina Mills, St. Louis, Mo	*Middletown:* H. G. Wadhams	9.93	3.88	26.69	3.18	52.02	4.30
		Guaranty	....	....	*27.00*	....	....	*3.20*
809	Blatchford's Calf Meal. Blatchford Calf Meal Co., Waukegan, Ill.	*Middletown:* Meech & Stoddard, Inc.	10.05	6.38	24.38	5.85	47.81	5.53
		Guaranty	....	....	24.00	....	....	5.00
	Poultry Feed.							
846	Buttermilk Laying Mash. Basic Feeds Co., Lockport, Ill.	*Stamford:* W. L. Crabb	8.18	5.25	21.13	4.98	54.73	5.73
		Guaranty	....	....	18.00	5.00	....	5.00
792	Parex Dry Mash. Bosworth Bros., Putnam, Conn	*Putnam:* Bosworth Bros	8.85	5.98	18.94	6.28	54.37	5.58
		Guaranty	....	....	18.00	....	....	4.50
832	Buckingham's Dry Mash. C. Buckingham & Co., Southport, Conn.	*Southport:* C. Buckingham & Co	9.48	7.35	20.00	4.55	52.92	5.70
		Guaranty	....	....	19.00	....	....	5.00
760	Ego Dry Mash. C. W. Campbell Co., Westerly, R. I.	*Westerly:* C. W. Campbell Co.	8.48	8.41	22.25	7.83	47.10	5.93
		Guaranty	....	....	18.00	....	....	2.00
765	Fortune Egg Mash with Buttermilk. Coles Co., Middletown, Conn.	*Colchester:* David Shea	7.58	11.07	21.31	5.68	49.01	5.35
		Guaranty	....	....	17.00	....	....	3.50
878	Laying Mash. C. A. Cowles, Plantsville, Conn	*Plantsville:* C. A. Cowles	8.10	9.34	17.63	6.78	53.12	5.03
		Guaranty	....	....	18.00	....	....	4.00
879	Cowles' Meato Mash. C. A. Cowles, Plantsville, Conn.	*Plantsville:* C. A. Cowles	8.98	4.87	22.00	5.48	53.59	5.08
		Guaranty	....	....	22.00	....	....	5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
703	Wirthmore Buttermilk Mash Feed. C. M. Cox Co., Boston, Mass.	*West Cheshire:* G. W. Thorpe	8.43	12.34	21.75	6.03	45.05	6.40
		Guaranty	....	....	20.00	....	....	4.00
861	C-B Mash. The Crittenden Benham Co., New Haven, Conn.	*New Haven:* The Crittenden Benham Co.	7.30	11.41	18.94	6.05	49.65	6.65
		Guaranty	....	....	18.00	....	....	5.00
836	Crosby's Growing Feed. Crosby Milling Co., Brattleboro, Vt.	*Norwalk:* Francis H. Leggett & Co.	9.88	8.42	18.75	4.83	52.97	5.15
		Guaranty	....	....	15.00	4.50	....	4.50
849	Davis Buttermilk Mash Feed. R. G. Davis & Sons, New Haven, Conn.	*Glenbrook:* Davis-Scofield Co.	8.90	6.89	18.25	6.13	54.00	5.83
		Guaranty	....	....	18.00	....	....	5.00
731	Egg Mash, Open Formula. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.60	5.71	19.88	5.43	53.95	5.43
		Guaranty	....	....	20.00	....	....	3.50
840	Eshelman's Laying Mash. John W. Eshelman & Sons, Lancaster, Pa.	*So. Norwalk:* Roodner Feed Co.	9.28	9.05	21.75	5.18	48.19	6.55
		Guaranty	....	....	20.00	....	....	5.00
881	Flory's Superior Egg Mash. Flory Milling Co., Bangor, Penn.	*Bloomfield:* Bloomfield Farmers' Exchg.	8.63	9.69	20.88	7.88	47.57	5.35
		Guaranty	....	....	20.00	....	....	5.50
773	Grandin's Poultry Dry Mash with Buttermilk. D. H. Grandin's Mill Co., Jamestown, N. Y.	*Norwich:* Norwich Grain Co.	8.50	12.25	20.56	5.43	48.01	5.25
		Guaranty	....	....	20.00	....	....	3.00
723	Red Comb Egg Mash. Hales & Hunter Co., Chicago, Ill.	*New Britain:* Stanley Svea Grain & Coal Co	8.80	8.45	20.06	4.83	52.21	5.65
		Guaranty	....	....	20.00	....	....	4.50
841	Premier Laying Mash. Francis H. Leggett & Co., Stamford, Conn.	*Stamford:* Francis H. Leggett & Co.	9.70	7.47	22.06	5.00	49.19	6.58
		Guaranty	....	....	20.00	....	....	5.00
876	Storrs Egg Mash. E. Manchester & Sons, Winsted, Conn.	*Winsted:* E. Manchester & Sons	7.85	9.03	19.63	5.23	51.91	6.35
		Guaranty	....	....	18.00	....	....	4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
845	Armour's Cak-Cak Laying Mash. Maple Flake Mills, Chicago, Ill	*Stamford:* W. L. Crabb	9.75	8.61	18.75	3.50	54.99	4.40
		Guaranty	....	....	20.00	....	....	3.00
844	Iroquois Laying Mash. Maple Flake Mills, Chicago, Ill	*Stamford:* W. L. Crabb	8.63	8.50	20.56	6.43	49.08	6.80
		Guaranty	....	....	20.00	....	....	5.00
843	Bull Brand Laying Mash. Maritime Milling Co., Buffalo, N. Y.	*Stamford:* W. L. Crabb	8.88	8.75	20.63	7.03	48.71	6.00
		Guaranty	....	....	20.00	....	....	5.00
806	Red Wing Dry Mash. Meech & Stoddard, Inc., Middletown, Conn.	*Hartford:* Meech Grain Co	8.40	8.46	18.75	6.40	52.49	5.50
		Guaranty	....	....	17.00	....	....	5.50
856	Bonnie Booster with Buttermilk. Park & Pollard Co., Boston, Mass	*New Haven:* R. G. Davis & Sons	9.93	5.38	15.25	2.93	63.23	3.28
		Guaranty	....	....	12.00	....	....	3.00
818	Lay or Bust Dry Mash. Park & Pollard Co., Boston, Mass	*Ansonia:* Ansonia Flour & Grain Co.	9.73	6.74	18.13	5.38	55.49	4.53
		Guaranty	....	....	18.00	....	....	1.50
885	Platco Laying Mash. Frank S. Platt Co., New Haven, Conn	*New Haven:* Frank S. Platt Co	7.78	10.22	20.75	6.68	48.84	5.73
		Guaranty	....	....	18.94	....	....	5.38
858	Pratt's Baby Chick Food. Pratt Food Co., Philadelphia, Pa	*New Haven:* R. G. Davis & Sons	8.70	8.54	13.00	2.55	63.16	4.05
		Guaranty	....	....	11.50	....	....	3.50
860	Purina Chicken Chowder. Purina Mills, St. Louis, Mo	*New Haven:* The Crittenden Benham Co.	8.45	8.22	20.06	6.23	52.11	4.93
		Guaranty	....	....	18.00	....	....	4.00
857	Ful-O-Pep Chick Starter. Quaker Oats Co., Chicago, Ill.	*New Haven:* R. G. Davis & Sons	7.75	8.76	17.38	4.90	55.01	6.20
		Guaranty	....	....	15.00	6.50	....	5.00
859	Ful-O-Pep Egg Mash. Quaker Oats Co., Chicago, Ill.	*New Haven:* R. G. Davis & Sons	7.73	9.23	20.44	6.98	49.89	5.73
		Guaranty	....	....	20.00	....	....	4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
829	Quisenberry Quality "Big 4" Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	*Farmington:* Winchell Smith Grist Mill	8.88	6.19	17.88	8.15	54.27	4.63
		Guaranty	....	....	17.00	6.00	....	4.00
828	Quisenberry Quality Buttermilk Laying Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	*Farmington:* Winchell Smith Grist Mill	9.70	6.34	19.88	5.63	53.80	4.65
		Guaranty	....	....	18.00	....	....	4.00
689	Vitality Egg Mash. Rosenbaum Bros., Chicago, Ill.	*Hamden:* I. W. Beers	9.40	9.30	20.56	5.65	49.54	5.55
		Guaranty	....	....	20.00	7.00	....	4.00
683	S. G. Home Made Milk Mash. The Seymour Grain & Coal Co., Seymour, Conn.	*Seymour:* Seymour Grain & Coal Co.	8.90	7.49	18.06	6.58	53.69	5.28
		Guaranty	....	....	18.00	9.00	....	4.50
824	Mill Streams Lightnin Laying Mash. Winchell Smith Grist Mill, Farmington, Conn.	*Farmington:* Winchell Smith Grist Mill	9.80	8.86	19.75	5.68	51.31	4.60
		Guaranty	....	....	16.00	....	....	3.00
716	Syragold Egg Mash. Syracuse Milling Co., Syracuse, N. Y.	*Plainville:* W. S. Eaton	8.65	7.73	19.94	7.05	51.56	5.07
		Guaranty	....	....	18.00	....	....	3.00
820	Syragold Egg Mash. Syracuse Milling Co., Syracuse, N. Y.	*Granby:* E. H. Rollins	8.70	7.27	20.00	7.30	51.83	4.90
		Guaranty	....	....	18.00	....	....	3.00
693	Egatine. Tioga Mill & Elevator Co., Waverly, N. Y.	*North Haven:* W. L. Thorpe	9.03	8.28	26.44	4.68	45.09	6.48
		Guaranty	....	....	23.00	....	....	2.50
763	Big Y Laying Mash. Yantic Grain & Products Co., Norwich, Conn.	*Yantic:* Yantic Grain & Products Co.	9.25	8.33	21.13	6.43	49.18	5.68
		Guaranty	....	....	20.00	....	....	4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feeds—Continued *(Beef Scrap.)*							
851	Big 50 Meat & Bone Scrap. American Agricultural Chemical Co., N. Y. . .	*New Canaan:* C. H. Fairty Co.	5.05	24.82	53.94	2.36		13.83
		Guaranty	....	....	50.00	....		6.00
871	Protox Meat & Bone Scrap. American Agricultural Chemical Co., N. Y. . .	*New Milford:* Geo. E. Ackley Co.	5.03	23.64	51.94	3.14		16.25
		Guaranty	....	....	55.00	....		6.00
756	Beach Soap Co., Lawrence, Mass.	*Mystic:* J. L. Manning	6.10	33.24	43.13	1.90	3.20	12.43
		Guaranty	....	....	35.00	....	....	10.00
690	Cooked Meat Scrap for Poultry. Conn. Fat Rendering & Fertilizer Corp., New Haven, Conn.	*Hamden:* I. W. Beers	6.75	29.06	50.00	2.70	1.44	10.05
		Guaranty	....	....	40.00	....	....	8.00
696	Frisbie's Poultry Feed Animal Products. L. T. Frisbie Co., New Haven, Conn.	*Wallingford:* A. E. Hall	6.03	33.03	44.75	2.10	0.69	13.40
		Guaranty	....	....	40.00	....	....	8.00
870	Frisbie's Poultry Feed. The L. T. Frisbie Co., New Haven, Conn.	*New Milford:* Geo. T. Soule	6.20	28.76	49.38	2.83		12.83
		Guaranty	....	....	50.00	....		8.00
813	Greene's Poultry Scraps. Green Chicken Feed Co., Marblehead, Mass.	*Middletown:* Meech & Stoddard, Inc.	4.35	44.80	32.13	8.24		10.48
		Guaranty	....	....	25.00	....		5.00
804	Cooked Meat & Bone Scraps. A. G. Markham & Co., Springfield, Mass.	*Stafford Springs:* Dennis Grain Mill	7.58	33.63	47.56	2.80		8.43
		Guaranty	....	....	40.00	....		8.00
780	Marsh's Pure Ground Scraps for Poultry. Geo. E. Marsh Co., Lynn, Mass	*Norwich:* Yantic Grain & Products Co.	5.00	31.48	45.25	4.67		13.60
		Guaranty	....	....	40.00	....		8.00
850	High Grade Meat and Bone Scraps. Martin & Maurer, Harrison, N. J. .	*New Canaan:* C. H. Fairty Co.	5.88	27.06	51.38	3.20		12.48
		Guaranty	....	....	50.00	....		10.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feeds—Concluded. (*Beef Scrap.*)							
798	Blue Seal Meat Scraps. New England By-Products Corp., Lawrence, Mass.	*So. Coventry:* E. W. Latimer	5.90	27.28	52.63	2.31		11.88
		Guaranty	....	....	50.00	3.00	....	5.00
717	White Seal Meat Scraps. New England By-Products Corp., Lawrence, Mass.	*Plainville:* W. S. Eaton	5.80	36.93	40.94	0.90	2.03	13.40
		Guaranty	....	....	40.00	4.00	....	5.00
761	Pawtucket Rendering Co., Pawtucket, R. I.	*Westerly:* C. W. Campbell Co.	5.18	32.52	50.00	4.15		8.15
		Guaranty	....	....	40.00	....		8.00
740 [1]	Rauh's Meato. E. Rauh & Sons Animal Feed Co., Indianapolis, Ind.	*Hazardville:* Amos D. Bridges' Sons	4.55	5.75	76.25	0.40	....	13.05
		Guaranty	....	....	75.00	1.00	....	6.00
852	Swift-Sure Ground Beef Scrap for Poultry. M. L. Shoemaker & Co., Philadelphia, Pa.	*East Haven:* F. A. Forbes	4.98	29.82	52.13	2.94		10.13
		Guaranty	....	....	55.00	....		10.00
732	Cooked Meat and Bone Scraps. Springfield Rendering Co., Springfield, Mass.	*Suffield:* Spencer Bros.	7.18	30.30	51.25	1.80	0.94	8.53
		Guaranty	....	....	40.00	....	....	8.00
812	Meat Scrap for Poultry. John T. Stanley Co., New York, N. Y.	*Middletown:* Meech & Stoddard, Inc.	6.10	28.90	43.88	8.19		12.93
		Guaranty	....	....	40.00	....		10.00
869	Vico High Protein Meat Scraps. Van Iderstine Co., Long Island City, N.Y.	*New Milford:* Geo. T. Soule	7.18	18.47	58.69	....	3.11	12.55
		Guaranty	....	....	55.00	....	....	5.00
776	Royal Worcester Beef Scrap. Worcester Rendering Co., Auburn, Mass.	*Norwich:* Norwich Grain Co.	7.30	28.89	48.25	5.31		10.25
		Guaranty	....	....	40.00	....		8.00
782	Royal Worcester Special Meat Scrap. Worcester Rendering Co., Auburn,	*Jewett City:* Red Wing Feed Store	6.28	21.78	56.13	2.71		13.10
		Guaranty	....	....	50.00	....		8.00

TABLE III. FEEDS NOT CONFORMING TO GUARANTIES OR OTHERWISE ILLEGAL.

Station No.	Manufacturer and Brand	Protein Deficiency	Fat Deficiency	Fiber Excess	Remarks
	COTTONSEED MEAL.	%	%	%	
868	Steerboy. S. P. Davis, Little Rock, Ark.	....	....	....	Wire tags, illegal.
778	Dixie. Humphreys-Godwin Co., Memphis, Tenn.	7.37	....	3.88	....
749	Neal's Choice. L. B. Lovitt & Co., Memphis, Tenn.	8.62	....	3.93	....
	HOMINY FEED.				
701	The Patent Cereals Co., Geneva, N. Y.	....	....	....	Wire tags, illegal.
	DAIRY FEED				
754	Nobotheration Dairy Ration. C. W. Campbell Co., Westerly, R. I.	1.56	....	....	....
785	Wirthmore 20 Protein Dairy Feed. C. M. Cox Co., Boston, Mass.	....	1.22	....	....
709	Elmore Milk Grains. Elmore Milling Co., Oneonta, N. Y.	....	0.47	....	....
743	Bull Brand Dairy Ration. Maritime Milling Co., Buffalo, N. Y.	1.50	....	....	....
766	Uncle John's 24% Cream Pot Ration. Ontanio Milling Co., Oswego, N. Y.	2.37	....	....	....
687	Pillsbury's 24% Dairy Feed. Pillsbury Flour Mills Co., Minneapolis, Minn.	1.19	....	....	....
825	Mill Streams Boomerang Dairy Feed. Winchell Smith Grist Mill, Farmington, Conn.	....	0.27	....	....
	STOCK FEED.				
797	Pennant Brand Stock Feed. E. W. Bailey & Co., Swanton, Vt.	....	0.87	....	....
762	Nobotheration Stock Feed. C. W. Campbell Co., Westerly, R. I.	....	1.27	....	....
848	Davis Stock Feed. R. G. Davis & Sons, New Haven, Conn.	....	1.17	....	....
715	Flory's Special Stock Feed. Flory Milling Co., Bangor, Penn.	....	....	1.24	....
835	Nabob Stock Feed. Francis H. Leggett & Co., Norwalk, Conn	....	0.42	....	....

TABLE III. FEEDS NOT CONFORMING TO GUARANTIES OR OTHERWISE ILLEGAL.

Station No.	Manufacturer and Brand	Protein Deficiency	Fat Deficiency	Fiber Excess	Remarks
	POULTRY FEEDS.	%	%	%	
845	Armour's Cak-Cak Laying Mash. Maple Flake Mills, Chicago, Ill.	1.25	....	....	....
829	Quisenberry Quality "Big 4" Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	....	....	2.15	....
	BEEF SCRAP.				
871	Protox Meat & Bone Scrap. American Agricultural Chemical Co., New York City	3.06	....	....	....
740	Rauh's Meato. E. Rauh & Sons Animal Feed Co., Indianapolis, Ind.	....	....	....	Wire tags, illegal.
852	Swift-Sure Ground Beef Scrap for Poultry. M. L. Shoemaker & Co., Philadelphia, Pa.	2.87	....	....	....

Over the five-year period 1920 to 1924 inclusive, from 8 to 12 per cent. of samples examined have been found deficient in individual years. The combined data for this period shows that of 864 samples analyzed 83 have been deficient in one or more of the three items, protein, fat and fiber, which is 9.6 per cent. of the total. In other words 90.4 per cent. of the samples examined have substantially met their guaranties. The distribution of these deficiencies is shown in Table IV.

TABLE IV. SUMMARY AND DISTRIBUTION OF DEFICIENCIES FOR FIVE YEAR PERIOD, 1920 TO 1924 INCLUSIVE.

	No. Samples	No. Deficient
Cottonseed Meal	60	9
Cottonseed Feed	4	1
Linseed Meal	27	0
Wheat Bran	70	1
Wheat Feed	42	1
Wheat Middlings	80	2
Rye Products	9	0
Wheat and Rye	1	0
Buckwheat	2	0
Oat Products	4	0
Corn Gluten Feed	25	1
Corn Gluten Meal	3	0
Corn Meal	4	0
Hominy Feed	58	11
Distillers' and Brewers' Grains	15	3
Dried Beet Pulp	25	0
Proprietary Feeds (including Poultry Feeds)	429	53
Miscellaneous:		
Peanut Oil Meal	1	1
Cocoanut Oil Meal	1	0
Corn Flakes	1	0
Red Dog Flour	3	0
Total	864	83

MISCELLANEOUS SAMPLES.

In Table V are included samples submitted by purchasers or others interested. Most of these have required only partial or complete fodder analyses; but in a few cases examinations were made for poisons.

TABLE V. ANALYSES OF FEEDING STUFFS

Station No.	Material	Submitted by
	CORN PRODUCTS.	
23162	Buffalo Gluten Feed "A"	*Granby:* P. J. Rogers
23163	Buffalo Gluten Feed "B"	P. J. Rogers
	OAT PRODUCTS.	
898	Canada Oats No. 44	*Cromwell:* Edmund Peterson
900	Ground Oats No. 38—40	Edmund Peterson
1183	Ground Oats	*Berlin:* D. B. Hubbard, Jr.
	WHEAT PRODUCTS.	
897	Red Wheat	*Cromwell:* Edmund Peterson
901	Gold Medal Wheat Bran	Edmund Peterson
902	H. Wheat Middlings	Edmund Peterson
	PROPRIETARY MIXED FEEDS.	
	Dairy Feeds and Rations.	
23366	Dairy Feed	*Hazardville:* Amos D. Bridges' Sons
599	Dairy Ration	*Plantsville:* C. A. Cowles
23005	Big Y Dairy Ration	*Norwich:* S. C. Beebe
22808	Dairy Ration Home Mixture	*Hazardville:* Amos D. Bridges' Sons
22838	Fulpail Dairy Ration No. 1	*Thomaston:* Nils Swanson
22839	Fulpail Dairy Ration No. 2	Nils Swanson
22836	Fulpail 20% Eastern States Ration	*Norwich:* Walter T. Clark
22835	Milkmore 24% Eastern States Ration	Walter T. Clark
176	Red Wing Junior Dairy Ration	*Middletown:* Meech & Stoddard, Inc.
177	Red Wing Special Dairy Ration	Meech & Stoddard, Inc.
935	Red Wing Special Dairy Ration	*Middlefield:* Lyman Farm
932	Uncle John's 24% Cream Pot Ration	Lyman Farm
22828	Uncle John's 24% Cream Pot Dairy Ration	*Middletown:* The Coles Company
23284	Wadfeeco Dairy Ration	*New Haven:* S. C. Salmon
	Poultry Feeds.	
23004	Big Y Laying Mash	*Norwich:* S. C. Beebe
22912	Big Y Laying Mash	The Yantic Grain & Products Co.
22683	Eastern States Egg Mash	*Gaylordsville:* Miss H. M. Bamwell
22684	Eastern States Egg Mash	Miss H. M. Bamwell
22837	Egg Mash 22% Eastern States Ration	*Norwich:* Walter T. Clark
934	Laying Mash	*Meriden:* Reliable Grain & Feed Co.
895	Cracked Corn	*Cromwell:* Edmund Peterson
899	Frisbie Meat and Bone Scraps	Edmund Peterson
23272	Beef Scrap	*Middletown:* Middlesex Refining Co.
294	Bran A-1	*Cromwell:* Edmund Peterson

SUBMITTED BY INDIVIDUALS.

Station No.	Pounds per Hundred						Remarks
	Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.	Ether Extract (Crude fat).	
23162	....	....	24.56	....	....	....	
23163	....	....	25.63	....	....	....	
898	9.40	3.34	11.00	9.18	61.60	5.48	
900	10.15	2.99	11.50	9.65	60.56	5.15	
1183	1.97	....	12.31	9.13	....	....	
897	10.83	1.78	12.38	2.20	70.86	1.95	
901	10.10	6.04	16.00	8.90	53.71	5.25	
902	10.28	4.90	15.88	8.30	55.09	5.55	
23366	....	....	20.94	....	....	....	
599	8.10	5.74	26.56	9.18	44.03	6.70	
23005	....	....	26.94	....	....	....	
22808	9.56	....	20.75	....	....	5.21	
22838	....	....	21.75	....	....	....	
22839	....	....	23.81	....	....	....	
22836	....	....	21.63	....	....	....	Guaranty; protein 20%.
22835	....	....	25.75	....	....	....	Guaranty; protein 24%.
176	....	....	18.94	....	....	....	
177	....	....	22.63	....	....	....	
935	....	....	20.88	....	....	6.20	Guaranty; protein 24.00, fat 6.00, fiber 9.00%.
932	....	....	23.75	....	....	6.45	Guaranty; protein 24.00, fat 5.5, fiber 9.00%.
22828	....	....	23.19	....	....	....	Guaranty; protein 24%.
23284	....	....	25.00	....	....	....	Guaranty; protein 24.00, fat 5.00, fiber 7.00%.
23004	....	....	22.19	....	....	....	
22912	....	....	22.06	....	....	....	Guaranty; protein 20.00, fat 4.00%.
22683	6.16	4.91	21.75	6.58	55.50	5.10	Guaranty; protein 22.00, fat 3.5 fiber, 7.00%.
22684	6.14	5.12	22.56	6.59	54.43	5.16	Guaranty; protein 22.00, fat 3.5, fiber 7.00%.
22837	....	....	23.06	....	....	....	Guaranty; protein 22.00%.
934	6.20	13.32	25.75	5.50	41.73	7.50	
895	12.50	1.03	9.00	1.78	72.39	3.30	
899	6.30	31.41	45.88	....	2.11	14.30	Guaranty; protein 40.00, fat 8%.
23272	....	....	56.50	....	....	....	
294	....	....	15.31	....	....	....	

TABLE V. ANALYSES OF FEEDING STUFFS

Station No.	Material	Submitted by
	PROPRIETARY MIXED FEEDS—*Concluded.*	
	Poultry Feeds—Concluded.	
295	Middlings A-2	Edmund Peterson
296	Corn Meal A-3	Edmund Peterson
297	Beef Scrap A-4	Edmund Peterson
298	Dry Ground Fish A-5	Edmund Peterson
202	Chick Feed	*Waterbury:* F. E. Liebreich
23207	Skim Milk Curd	*Bridgeport:* The Mitchell Dairy Co.
22809	Scratch Feed	*Plainville:* Kosenko Bros. Poultry Farm
22810	Mash	Kosenko Bros. Poultry Farm
	MISCELLANEOUS.	
22757	Ground Oats	*New Haven:* Station Agent, stock of R. G. Davis
22758	Ground Oats	Station Agent, stock of Crittenden Benham Co.
22759	Ground Oats	*Thompsonville:* Station agent, stock of Geo. S. Phelps & Co.
22760	Ground Oats	*Hartford:* Station agent, stock of Meech Grain Co
22761	Ground Oats	*Guilford:* Station agent, stock of Fred C. Morse
22762	Ground Oats	*Middlefield:* Station agent, stock of Middlefield Grain & Coal Co.
22763	Ground Oats	*Middletown:* Station agent, stock of Meech & Stoddard, Inc.
23469	Feed	*Yantic:* Morris Pearson
22998	Wheat Bran	*Bridgeport:* Bridgeport Ice Delivery Co
22999	Brewers' Grains	Bridgeport Ice Delivery Co.
23000	Oats & Barley	Bridgeport Ice Delivery Co.
1111	Full Cream Milk Powder	*Stratford:* Samuel Wallace
460	Bran	*Middletown:* Station agent, stock of Meech & Stoddard, Inc.
461	Cottonseed Meal	Station agent, stock of Meech & Stoddard, Inc
462	Corn Meal	Station agent, stock of Meech & Stoddard, Inc
463	Experimental Ration	Station agent, stock of Meech & Stoddard, Inc
936	Feed	*Warehouse Point:* Edward Potwine
22519	Feed	*Storrs:* Dept. of Animal Husbandry
42	Feed	*Norwich:* H. F. Segelkers
23003	Dry Buttermilk	*Simsbury:* Robert Darling
333	Mash	*Bridgeport:* Homeland Grocery Store
896	Corn Meal	*Cromwell:* Edmund Peterson
1016	Corn	*Orange:* Howard Treat

SUBMITTED BY INDIVIDUALS.

Station No.	Pounds per Hundred						Remarks
	Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum etc.)	Ether Extract (Crude fat).	
295	....	....	16.81	....	....	....	
296	....	....	10.31	....	....	....	
297	....	....	50.31	....	....	....	
298	....	....	31.94	....	....	....	
202	....	....	20.44	....	....	....	
23207	68.96	2.73	24.50	....	....	0.54	
22809	10.67	....	11.31	....	....	3.50	
22810	8.58	....	22.06	....	....	5.62	
22757	11.35	3.05	13.38	6.29	60.98	4.95	
22758	11.75	3.11	14.31	7.88	58.57	4.38	
22759	10.81	3.31	12.38	8.96	59.30	5.24	
22760	11.41	3.13	13.06	7.40	60.48	4.52	
22761	11.59	3.01	12.88	7.51	61.04	3.97	
22762	10.81	3.24	12.56	8.68	60.37	4.34	
22763	11.45	3.15	12.13	8.24	60.55	4.48	
23469	....	....	23.88	....	....	....	
22998	....	....	16.13	....	....	....	
22999	....	....	22.94	....	....	....	
23000	....	....	14.00	....	....	....	
1111	....	....	....	....	....	27.80	
460	10.58	6.22	14.44	10.00	53.14	5.62	
461	8.70	5.77	36.44	12.73	30.28	6.08	
462	13.44	1.56	9.50	2.43	69.09	3.98	
463	11.43	4.08	17.75	7.43	54.25	5.06	
936	....	....	20.25	....	....	....	
22519	6.72	0.66	9.38	0.45	81.99	0.80	
42	....	....	17.44	....	....	....	
23003	....	....	31.77	....	....	3.98	
333	9.67	7.38	21.38	5.32	50.00	6.25	
896	11.18	1.74	10.25	3.18	69.10	4.55	
1015	18.00	....	....	....	....	....	

TABLE V. ANALYSES OF FEEDING STUFFS

Station No.	Material	Submitted by
	MISCELLANEOUS—*Concluded.*	
1191	Eastern States Mash.................	*Bolton:* J. W. Phelps.............
1195	Ground Oats.........................	*New Haven:* Crittenden Benham Co.
1196	Corn Meal..........................	*New Haven:* Crittenden Benham Co.
23286	Poultry Mash.......................	*South Glastonbury:* Harry W. Ferry
515	Hopper Mash.......................	*Seymour:* L. H. Smyth...........

SUBMITTED BY INDIVIDUALS.

Station No.	Pounds per Hundred						Remarks
	Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.	Ether Extract (Crude fat).	
1191	....	....	....	....	....	....	Composed of wheat, corn and oat products with meat scraps all in substantial proportions.
1195	....	....	....	....	....	....	Chiefly oats, trace corn and wheat; no rye found.
1196	....	....	....	....	....	....	As claimed; slight contamination with oats, wheat and buckwheat.
23236	....	....	....	....	....	....	No evidence of mouldy or smutted grains.
515	....	....	....	....	....	....	No poisons detected.

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New Haven, Connecticut

Perithecia of Thielavia basicola Zopf in Culture

And

The Stimulation of their Production by Extracts from other Fungi

FLORENCE A. McCORMICK

BOTANICAL DEPARTMENT

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Perithecia of Thielavia basicola Zopf in Culture and the Stimulation of their Production by Extracts from other Fungi.

By

FLORENCE A. MCCORMICK.

During a disease survey of tobacco in the summer of 1920, *Thielavia basicola* Zopf was found to be unusually abundant, the heavy rains in the early part of the season favoring its development. Perithecia were plentiful and, in some cases, they were found to be deeply embedded in the tissues of the host. It, therefore, seemed worth while to attempt to establish more definitely the connection of the ascospore stage with the chlamydospores and endoconidia, all three spore forms being known by the name *Thielavia basicola* Zopf, since Peglion, in 1900, (19) has given the only published record of perithecia in artificial culture. Aside from its scientific interest, it is of economic value to know whether there are two fungi or only one, possessing all spore forms, parasitic on its agricultural hosts. *Thielavia basicola* Zopf is a well known parasite, chiefly serious on tobacco, the violet and many of the Leguminosae. Johnson mentions thirty-nine hosts compiled by previous investigators and gives sixty-six additional ones.

HISTORICAL.

The literature cited below concerns, in the main, the perithecia commonly assumed to be the perfect stage of the fungus producing chlamydospores and endoconidia known as *Thielavia basicola* Zopf and is only a small part of the mass of publications bearing chiefly on the economic problems connected with that fungus.

In 1850 Berkeley and Broome (2) found the chlamydospores at the base of stems of peas and *Nemophila auriculata* and gave the fungus the name of *Torula basicola* n. s. In 1876 Zopf (33) published an article in which he described a fungus growing on *Senecio elegans* L. in the Botanical Garden of Berlin and he recognized the chlamydospores as identical with those described and figured by Berkeley and Broome. In addition to the chlamydospores, he described endoconidia, ascospores and spermatia. The last spore form has not been observed by other workers and Zopf himself omitted it from a later publication. Due to the association of perithecia with the chlamydospores and endoconidia, Zopf, in his publication of 1876, changed the name, *Torula basicola*, given by Berkeley and Broome, to *Thielavia basicola* and placed the fungus in the Perisporiaceae. Since the date of that publication the fungus bearing chlamydospores and endoconidia, noted above, has also been known as *Thielavia basicola* Zopf and the perithecia

occasionally found with them have been considered the perfect stage of that fungus. In August, 1876, Sorokin (30) announced the finding of a new fungus on the roots of *Cochlearia armoracia*. He described the chlamydospores, but, not recognizing them as belonging to the fungus found by Berkeley and Broome twenty-six years before, nor knowing of Zopf's discovery, named the fungus *Helminthosporium fragile* sp. n. Saccardo lists the fungus in three different places and under as many different names. He retains the name for the chlamydospore stage given by Berkeley and Broome (23), but he changed the name *Helminthosporium fragile* Sorok., given by Sorokin, to *Clasterosporium fragile* (Sorok.) Sacc. (24). He also gives a description of *Thielavia basicola* Zopf (22), including in it perithecia along with the other spore forms.

In his paper of 1891, Zopf (34) gives a detailed account of a new disease of lupines which he found to be due to *Thielavia basicola*. He did not make cultures but, since perithecia were again found associated with chlamydospores and endoconidia, he still considered the fungus undoubtedly an ascomycete and retained the name *Thielavia basicola*. This opinion has been generally accepted although the relationship of perithecia to endoconidia and chlamydospores has not been considered completely established, since perithecia are not obtained in artificial cultures and only infrequently found in nature. In classification of fungi, however, *Thielavia basicola* Zopf is invariably placed with the ascomycetes, on the supposition that chlamydospores, endoconidia and perithecia belong to the same fungus, and taxonomists agree that it is closely related to the Aspergillaceae.

Previous to the report from this Station in 1921 (14), Peglion (19) is the only person who had obtained perithecia in a culture. He found perithecia only once, these occurring after he moistened a three year old culture on potato plugs with a 6% tartaric acid solution. A week later he discovered that perithecia had developed. Prof. Thaxter, 1891, (31), who found this fungus on violet roots and who was the first to report its presence in America, did not find perithecia and he has never been fully convinced of their relationship to the other two spore forms. Sorauer (29), 1895, does not question the relationship. Oudemans (18) considers *Thielavia basicola* Zopf as belonging to the Perisporiaceae and he illustrates only a mature perithecium, a mature ascus and a young ascogonium, omitting any reference to the asexual spores. Cappelluti-Altomare (4) found perithecia associated with chlamydospores on tobacco roots. Aderhold (1) failed to obtain perithecia in his cultures and did not find them in plants infected with that fungus. In discussing perithecia Clinton, 1906, (5) says, "So far as our own observations go we could not positively assert their relationship to the other spore forms of the root rot fungus, but from their presence and the observations of others there seems to be no reason for doubting this relationship." In his report of the following year

Dr. Clinton (6) further says "During the past year and a half the fungus has been under observation in cultures with various media in an attempt to develop the ascospore stage. This has not been obtained, though the fungus was grown on tobacco roots on which this stage occurs in nature in Connecticut. Fresh tobacco roots containing the fungus were sent to Professor Thaxter, who tried to isolate the ascospores by the Barber method and obtain cultures directly from them—our cultures having come originally from the endospores, or possibly from the chlamydospores—but he was not successful in obtaining such cultures. Professor Thaxter has, on the other hand, a culture of another species of *Thielavia* which forms ascospores, but never the endospores and chlamydospores. These facts possibly may indicate that the ascospore stage has no relationship to our fungus, and that it occurs on the tobacco roots as a parasite of the fungus rather than as a stage of it." Duggar(8) says, "The association of the ascosporous stage with the others and the apparent continuity of mycelium are believed to show genetic connection." Gilbert (12) also accepts this hypothesis and states that he was fortunate to obtain a perithecium attached to the same hypha which bore an endoconidiophore, but that he never saw an ascus. Foex (10) and Reddick (21) found violets infected with *Thielavia basicola* Zopf and accepted the relationship of perithecia with the other spore forms. Johnson (15) considers association of the perithecia with chlamydospores in nature as an evidence of their relationship. Peters (20), who did not obtain perithecia in his cultures and only once found them in his investigations in the field, questions their connection with the chlamydospores and endoconidia.

Ferraris (9) distinguishes the asexual stage from the ascospore stage, applying the name *Thielaviopsis basicola* (Berk.) Ferraris to the fungus which bears the chlamydospores and endoconidia and the name *Thielavia basicola* Zopf to the ascospore stage, not, however, implying two distinct fungi. To simplify the nomenclature in this paper the writer is following hereafter the terminology of Ferraris for these different stages.

Experiments With a Conidum-Chlamydospore Culture.

In August, 1920, a culture of *Thielaviopsis basicola* (Berk.) Ferraris, culture No. 396, was isolated from tobacco roots in which there were large numbers of perithecia associated with chlamydospores. Pieces of the infected roots were thoroughly washed in running water, followed by sterilized water, and put on oat agar containing some tobacco leaf extract. An endoconidium-chlamydospore culture was obtained, but no perithecia were produced.

Peglion's result indicated that nutrition might be a factor in the development of perithecia. Repeated efforts were made, therefore, to induce the formation of perithecia by the use of various kinds of media, by the provision of an excess of food, by

slow starvation and, finally, by partial starvation followed by an abundance of food.

It was thought that tobacco extract might be a favorable food, and agar was made with it, alone and in combination with other substances. Sterilized tobacco seedlings were used alone and made up with agar and soil. Stock agars were made with ground peas, beans, oats, corn, peanuts, carrots, potatoes and beef extract. These media were used alone and also in combination with other nutrients, such as glucose and yeast, and a series of cultures, grading from slightly acid to slightly alkaline, was also tried. Plugs of carrot, potato, pineapple and pea pods gave an excellent growth of the fungus, but orange and lemon plugs gave little or no growth. Transfers from luxuriant cultures to water agar were made, with the hope that a change from an abundance of food to a negligible quantity might be effective, and transfers were also made from one highly nutritive medium to another equally so, but of a different kind. With some cultures gelatine was substituted for agar. The results of these tests were strictly negative, not a single culture showed a development of perithecia. Eighteen cultures on various media in protected test tubes, were planted outdoors in the spring and were left throughout the summer to see if the natural temperature of the soil might be a factor. Here again the results were entirely negative.

Perithecia in Culture.

In view of the negative results of the nutrition experiments it seemed worth while to determine whether or not perithecia of *Thielavia basicola* Zopf were the product of sexual strains. It was the intention of the writer to secure during the summer of 1921 as large a number of strains as possible for the purpose of making mixed cultures, but work on tobacco wildfire prevented making such collections. No other culture in addition to culture 396 was procured until later in the summer when some violet plants, heavily infected with chlamydospores of *Thielaviopsis basicola* (Berk.) Ferraris and perithecia of *Thielavia basicola* Zopf, were sent to Dr. Clinton from a greenhouse near Hartford. The writer visited the greenhouse and secured fresh material for culturing.

On August 9th pieces of these roots were cultured like the tobacco roots from which culture 396 was obtained, put into four Petri dishes and given the culture number 1351. On August 15th a slight growth of *Thielaviopsis basicola* was perceptible and transfers were made to three tubes of pea meal agar and three tubes of carrot agar. Two days later additional transfers were made to seven tubes of carrot agar. Nothing further was done with these cultures until October 6th. On that date one of the transfers made on pea meal agar, August 15th, showed chlamydo-

spores, endoconidia and perithecia. This tube was so contaminated with bacteria that, although sixteen transfers to tubes and two to Petri dishes were made, only a feeble growth was obtained. Subsequent transfers failed to restore it and the culture was finally lost. Of the seven transfers made on carrot agar, August 17th, one showed perithecia as well as chlamydospores and endoconidia and the remaining six had only chlamdospores and endoconidia. The growth of these six cultures was feeble on account of bacterial contamination and they, too, were finally lost. The culture containing perithecia along with the two asexual spores was also contaminated with bacteria and a fungus, still undetermined, but repeated culturing freed it from bacteria and later from the fungus.

There can be no doubt that culture 1351, obtained from the violet, is the fungus commonly known as *Thielavia basicola* Zopf. As stated above, Professor Thaxter (31), in 1891, announced the finding of this fungus on violets in Connecticut. In regard to perithecia he makes the following statement: "Zopf describes an ascosporic condition on which the genus *Thielavia* is founded, which has not been observed by the writer except as a parasite on other fungi (species of Isaria)." Foex (10) also found *Thielavia basicola* on violets and he gives a description of the disease and figures chlamydospores and perithecia with ascospores. In regard to the relationship of perithecia with the other spore forms he says: "Toutefois, il est hors de doute, après les observations de Zopf, que ces conceptacles appartiement bien au champignon qui constitue des endoconidies et des chlamydospores." In his paper on violet diseases Reddick (21) says: "The ascosporic stage, mentioned above, does not seem to play a particularly important role in the life cycle of this organism. If it were commonly developed it would seem reasonably certain that the numerous workers in this country and abroad would have seen and recorded its occurrence more frequently." Reddick's illustrations of infected violet plants agree well with Fig. 1, Plate XXXVII. The plants were considerably stunted and had comparatively small, yellowish leaves. In some cases the root system was almost entirely decayed, only a few lateral roots remained and the cortex of the main root was almost disintegrated, in places exposing the network of xylem.

Sections of some diseased violet roots, collected from the greenhouse mentioned above, showed numerous chlamydospores borne internally in the cortex as well as in the xylem, medullary rays and pith. Fig. 3, Pl. XXXVII, taken from such a root, also shows sclerotial masses of mycelium completely filling some of the cells. The chlamydospores shown in this figure are identical with those found in tobacco. Endoconidia from the violet are also like those in the culture isolated from the second host. In addition to Brierley's description (3) of endoconidia, Gilbert (12) has also described both spore forms and it is not necessary to repeat them here.

Perithecia, however, are not so well known. Some features noted by previous observers may here be re-emphasized and additional ones given. Perithecia have been found by the writer in roots of tobacco (Pl. XXXVII, Fig. 6), the pea (Pl. XXXVII, Fig. 5), the violet (Pl. XXXVII, Figs. 2 and 4) and recently of Antirrhinum. Sections have been made of the first three infected roots mentioned and the perithecia found in their tissues are alike in all. They are found chiefly in the cortex, but they are also located on the surface lying among masses of chlamydospores and no tissue of the root is entirely free from their invasion. The description of them as seen in culture, however, applies only to those isolated from the violet as no culture of them has been secured from any other host. In culture the perithecia of *Thielavia basicola* Zopf are globular or nearly so, but in nature the pressure of the surrounding cells of the host may make them some what elongated, one dimension occasionally being nearly twice as great as the other. The cells of the tightly twisted and intertwined hyphae, composing the enveloping sheath, vary in size so as to make the perithecium "rough" as Gilbert described it. The enveloping sheath is hyaline or slightly tinted. At maturity the perithecium looks black which is due to the very dark brown color of the ascospores lying within. There is no sign of an opening of any kind so that it may be considered a true cleistocarp. The asci are exceedingly fragile and by the time the ascospores are mature they have disintegrated leaving the ascospores free in the perithecial cavity. Asci, however, can be seen and obtained intact by gently pressing the cover glass over a nearly mature perithecium. If the ascospores are mature the ascus will invariably be ruptured. The asci are hyaline, nearly egg-shaped and contain eight ascospores. (Pl. XXXVIII, Fig. 23.)

The size of the perithecium has been commonly given as 80 to 100μ. The writer has found this size rather large. In the sections of the tobacco and pea roots the perithecia measure about the same, the maximum size of those measured in tobacco being 72μ and those of the pea 66μ. In the violet roots the perithecia were somewhat larger, the maximum dimension reaching as high as 99μ which, however, is exceptional even in this host. The larger size of the perithecia in the violet roots may possibly be due to greenhouse conditions. In culture, perithecia, which it is recalled were isolated from the violet, average about the same in size as those found in tobacco and pea roots.

The ascospores are small, dark brown and lenticular with one end blunt, from which germination occurs. In mass they appear black. The relatively large oil drop is the conspicuous feature of the cell contents. In the roots of the violet, tobacco and pea, as well as those in culture 1351, the general size is 10 to 13μ by 4.5 to 6.5μ.

The ascogonium begins as a small lateral branch attached at right angles to the main hypha. The early stages, in gross appear-

ance, apparently do not differ essentially from the figures given by Fraser and Chambers (11) for *Aspergillus herbariorum* and by Dale (7) for *Aspergillus repens* de Bary, although loose coils were not observed in this fungus. No attempt has been made to study the nuclear behavior and all the drawings of these stages, given here (Pl. XXXVIII, Figs. 11-22) were made from living material. The coil early becomes compact and additional hyphae soon bud out from the primary coil, thereby concealing it. The entire process takes place very quickly, as perithecia, apparently mature, can be seen along the sides of the tube eight days after the transfer has been made. Where observed, the early stages gave no indication of more than one hypha being involved in the ascogonial coil.

Possible Factors Inducing the Formation of Perithecia.

Having obtained perithecia in this accidental way the question arose as to the factors which brought forth their appearance. It was first thought that this might be a specialized form growing on this particular lot of violets. More violets were procured from the same greenhouse and cultures were made from individual plants. Ten additional cultures were isolated from as many different plants, but while all produced endoconidia and chlamydospores, none formed perithecia. If, then, culture 1351 were a unique strain it could not be general throughout the plants in the greenhouse, but one might expect to obtain perithecia from one-spore cultures of its endoconidia and chlamydospores. For the purpose of investigating this point one-endoconidium cultures were made. The spores were plated in stiff agar and the single germinating spores were transferred to tubes.

One-Conidium Cultures.

Of the 260 one-endoconidium cultures that were isolated from culture 1351 all showed a luxuriant development of endoconidia and chlamydospores, but no perithecia were found in them. This result apparently gave the solution as to the cause of the non-appearance of perithecia in some of the first transfers made from culture 1351. In an attempt to obtain transfers free from bacteria and the associated fungus an effort was made to touch the mycelium very lightly with the needle in order to carry over only endoconidia. For a time it was thought that perithecia were completely lost, but later it was found that transfers which included some of the mycelium always produced perithecia.

In isolating the germinating endoconidia it was noted that they vary somewhat in shape from the elongated narrow type with straight ends to short almost egg-shaped ones. The one-spore cultures were made from as many different types as possible, but the subsequent growth was alike in all.

Although no one-endoconidium cultures developed perithecia

it seemed possible that culturing two or more together might lead to their production. To facilitate the process of culturing, transfers from several tubes were frequently put into one tube so that while all the 260 cultures were used only 151 mixed cultures were made. In case perithecia developed in a tube containing transfers from more than two tubes the cultures producing them could be readily separated. No perithecia were in any of these tubes.

Chlamydospore Cultures.

For the same reason chlamydospore cultures were also isolated from culture 1351. They are, however, much more difficult to secure than endoconidium cultures, but by treating them with pepsin good germination was obtained. Pieces of culture, three or four weeks old, were thoroughly washed, since the numerous endoconidia, which are everywhere present in cultures, germinate so rapidly as to easily contaminate the chlamydospore cultures. Chlamydospores cling tenaciously together in chains and frequently more than one chlamydospore in a chain will germinate. In such cases the entire chain was transferred to a tube with the intention of accurately making single spore cultures in case perithecia were found in any of the tubes. Ninety chlamydospore cultures were included in the twenty mixed cultures made, each tube containing transfers from four or five cultures, but in none of these twenty tubes were perithecia produced. It was the intention to make an extensive series of plantings of one-endoconidium cultures with chlamydospore cultures, but investigations with the asco stage made this seem unnecessary and comparatively few were made. In no case did these produce ascospores but both asexual spores.

Investigations with the Ascospore Stage.

In studying the young stages of the ascogonium an effort was made to ascertain the relation of the ascogonial hypha to the mycelium which bears endoconidia and chlamydospores, since as noted above, culture 1351 is a mixed culture bearing all three spore forms. As the figures of *Aspergillus* also show, there was no indication here of hyphae from two different mycelia being concerned in the ascogonial coil. With the hope of getting a clearer view of the individual threads and also of being able to get cultures from them, small pieces of mycelium were cultured on clear agar with the idea that possibly an ascogonial hypha might become sufficiently separated so that it could be cut free from contaminating endoconidia, chlamydospores or the mycelium which bears them. All such attempts failed and one-ascospore cultures seemed to be the only method of getting accurate evidence of the relationship of the perithecia to the endoconidia and chlamydospores.

THE GERMINATION OF ASCOSPORES. Endoconidia are produced in such numbers that it is also necessary to free perithecia from them in order to procure pure ascopore cultures, for they germinate so readily that they contaminate the smaller and more slowly germinating ascospores. Pieces of culture, containing many perithecia, were thoroughly washed under a strong flow of tap water and finally in sterilized water. It was often necessary to tease away the endoconidia with sterilized needles.

Various methods, recommended for inducing germination of other ascospores, were tried without success. However, in the writer's experience the germination of ascospores of *Thielavia basicola* is very low, so this may be the cause of the failure. The first germination was obtained in a van Tieghem cell containing a trace of pepsin in the drop of water. All subsequent cultures were made by crushing the washed perithecia in a tube containing beef broth, a trace of pepsin and a minute particle of thymol. A better method, probably, would be to filter the solution containing pepsin through a Berkefeld filter, thus making thymol unnecessary. After about half an hour loops of the broth were transferred to melted beef agar which contained about 3% agar. A very clear agar is essential on account of the small size of the ascospores. Germination begins to appear in about five days. The open Petri dish was examined under the microscope and germinating ascospores transferred with a sterile needle to a suitable medium, in this case pea meal agar. By this method forty-two one-ascospore cultures were obtained. The germination of these spores was obtained only when pepsin was used and it was not determined whether or not they will germinate without it. The sole aim was to procure germination and no consideration was given to factors bringing it about. It is quite possible that freezing may be an aid to germination of the ascospores and the age of the spores may also be important. The best germination was secured with spores taken from cultures six weeks or two months old.

As previously stated the ascospore germinates at the blunt end (Pl. XXXVIII, Fig. 1) and the writer has not found more than one germ tube connected with a spore. Next to the spore coat, the germ tube has a one-sided bulbous enlargement and variation in diameter with considerable curling is characteristic of the older as well as the younger hyphae (Pl. XXXVIII, Figs. 9, 10). Especially in the early stages the cells are practically filled with a fine granular content (Pl.XXXVIII, Figs. 1-8). Growth is comparatively slow and although small test tubes were used it was several days before the delicate hyphae could be detected growing up on the sides of the tube and along the edge of the medium. The mycelium is white and on pea meal agar seldom shows the slightest tendency to become cottony, neither does it make a felt-like growth as does ***Thielaviopsis basicola***. The hyphae grow sparsely over the surface and down into the interior of the medium

None of the forty-two one-ascospore cultures produced either chlamydospores or endoconidia and although they have been in culture more than two years they have produced only perithecia and these usually developed sparingly and sometimes not at all. While there may be some difference of growth in the media commonly used for fungi, there has never been the least indication of even the rudiments of chlamydospores or endoconidia. Pea meal agar is the stock medium used and, while the growth on it is usually so delicate as to be readily overlooked, it seems to be a satisfactory one for this fungus, as all the forty-two cultures are still in good condition. The fungus also grows well on corn meal, prune, oat, potato, carrot and bean meal agars. However, there is often a difference in growth of cultures made at the same time and on the same agar. The factor, or factors, bringing about this condition have not been ascertained. With the above media in only a few cultures was there any approach to a cottony mycelium and, while the mycelium was abundant, it still remained delicate, being, in comparison with other fungi, very inconspicuous.

Mixed Cultures of Thielavia basicola Zopf and Thielaviopsis basicola (Berk.) Ferraris

The fact that none of the one-ascospore cultures produced either endoconidia or chlamydospores suggested that the ascospore cultures might be sexually related to the endoconidium-chlamydospore strains without, however, producing any asexual spores. With this idea in mind each of three one-ascospore cultures was cultured with eighty-one one-endoconidium cultures, from culture 1351, and with three *Thielaviopsis basicola* from tobacco, four from violet and one from garden peas. Perithecia were abundantly produced in all. Usually within six days immature perithecia could be detected in the tube placed under the microscope and in eight days almost mature perithecia could be seen with a hand lens. The remaining thirty-nine perithecial cultures were cultured with the eight cultures isolated from tobacco, violet and pea and they were also stimulated to produce an abundance of perithecia.

These results seemed to indicate that production of perithecia in this fungus was due to different sexual strains. However, it was early noted that there was a tendency to form perithecia in the one-ascospore cultures even though they were not cultured with the endoconidium-chlamydospore strains. In such cases perithecia were slower in making their appearance and increased in number as the culture grew older. Furthermore the forty-two cultures varied somewhat in this ability of forming perithecia when cultured alone and there was often a difference in cultures of the same strain made at the same time and on the same medium. In no case, however, did a single culture alone produce perithecia as quickly or as abundantly as when grown with endoconidium-

chlamydospore cultures. The factors which cause this difference in production of perithecia have not been ascertained. In autoclaves in which steam is in contact with the tubes a little more moisture at times collects in some tubes than in others, so it was thought that possibly the rigidity of the medium might be a factor. Cultures were made on media containing different concentrations of agar, but these gave no definite results, perithecial formation not being increased in any of them. A few cultures on oat agar, made in the usual way, formed a ring of perithecia along the upper edge of the medium, but these were not general throughout the tube and not always obtained. Possibly a slow drying combined with a favorable medium might be a factor. Occasionally transfers taken from an old dried culture make a more luxuriant growth and form more perithecia than those from newer cultures. For the experiments made on the production of perithecia an ascosporic culture, No. 1603, which alone seldom forms perithecia, was used.

Mixed Cultures of Thielavia basicola Zopf and other Fungi.

The writer is indebted to Prof. Thaxter for the suggestion of culturing *Thielavia basicola* Zopf with other fungi to see if the reaction with them is similar to that with *Thielaviopsis basicola* (Berk.) Ferraris.

First of all, however, *Thielavia basicola*, culture 1603, the strain which alone rarely produces perithecia, was cultured with the remaining forty-one strains of *Thielavia basicola*, but there was no additional stimulation in growth or perithecial formation. In this respect the results differ from those obtained by Miss Wineland (32) who found that two one-ascospore cultures of *Fusarium moniliforme*, grown together, stimulate the production of perithecia.

Other fungi were then tried. The same *Thielavia basicola* culture, No. 1603, was cultured with 120 strains and species, embracing 43 genera, belonging to Phycomycetes, Ascomycetes, Basidiomycetes and Fungi Imperfecti. In all the tests pea meal agar was used and in each case a transfer from one culture of *Thielavia bàsicola* was put into a tube with that from one other fungus. Many of the fungi grew so rapidly as to bury the delicate more slowly growing *Thielavia basicola* and no evidence of its mycelium could be detected, but in others both species survived in the fully mature culture.

As a result of these experiments it was found that *Thielavia basicola* Zopf produces abundant perithecia when it is cultured with *Cladosporium fulvum*, *Aspergillus umbrosus*, a strain of *Aspergillus glaucus*, *Eurotium amstelodami* and in a less degree with *Fusicladium pirinum*. In all cases the perithecia produced in these mixed cultures are exactly alike in every respect to those obtained in the original culture isolated from violet and no trace of chlamydospores or endoconidia was found in them.

It seems probable that if various other media were used or change of cultural conditions tried that other fungi might react in this same way.

It is interesting that results vary with different species of the same genus. While perithecia of *Thielavia basicola* were abundantly produced when that fungus was cultured with *Cladosporium fulvum*, isolated from tomato leaf by the writer, three *Cladosporium* cultures received from Dr. C. L. Shear, two of which were isolated from cranberry and one from blueberry, were unsuccessful. *Aspergillus umbrosus*, kindly determined by Drs. Charles Thom and Margaret Church, was obtained from peach preserves and *Aspergillus glaucus* strain and *Eurotium amstelodami* were received from the same investigators. Eight additional cultures of Aspergillus, received from them and nine others of the same genus, received from Dr. D. H. Linder, as well as one other species from this laboratory, had no effect in stimulating the production of perithecia. *Thielaviopsis paradoxa* has a striking resemblance to *Thielaviopsis basicola*, but two cultures received from Dr. J. P. Martin, Honolulu, and one isolated from banana stalk by the writer, were also unsuccessful. Two cultures of *Isaria*, received from Dr. F. J. Pritchard, had no effect in increasing the number of perithecia.

Results, similar to those given above, are recorded by Heald and Pool (13) who found that *Melanospora pampeana* responded in the production of perithecia when grown with *Fusarium moniliforme*, *Basisporium gallarum* and to a smaller extent with *Fusarium culmorum*. Their description of a one-ascospore culture of *Melanospora pampeana* as showing a "scanty scarcely distinguishable, white mycelium" might apply equally as well to the one-ascospore cultures of *Thielavia basicola* Zopf. However, in their one-ascospore culture or in transplants from it they never found perithecia, while on the other hand the one-ascospore cultures of *Thielavia basicola* Zopf spasmodically produce some perithecia when grown alone on an ordinary culture medium. In opposition to the results of Heald and Pool the writer so far has not been able to get a response of perithecia of *Thielavia basicola* on cultures of other fungi that have been heated in the autoclave or boiled in the open for twenty minutes.

Molliard (16), (17) found that *Ascobolus* produces perithecia when a bacterium is present in the culture and Sartory announced a similar association necessary for the production of ascospores in a yeast (25) and of perithecia in an Aspergillus (26), (27), (28).

The writer's experiments have been sufficiently repeated to demonstrate that *Thielavia basicola* Zopf, though possessing to some degree the ability to form perithecia when cultured alone, is greatly stimulated in the production of these structures when cultured in association with *Thielaviopsis basicola* (Berk.) Ferraris, *Cladosporium fulvum*, *Aspergillus umbrosus*, *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* and *Fusicladimu pirinum*.

Since *Thielavia basicola* Zopf does not form either the chlamydospores or endoconidia of *Thielaviopsis basicola* (Berk.) Ferraris, and since perithecial formation is stimualted equally well by other fungi, there seems to be no real justification for considering *Thielavia basicola* the perfect stage of *Thielaviopsis basicola.* Although the frequent association of these two fungi in nature and the fact that their relationship has long been accepted in literature make one reluctant to consider them as two distinct species, yet the cultural evidence is a strong argument in favor of such a view.

The Influence of Extracts upon Production of Perithecia.

The observations made upon the influence of extracts of some fungi upon production of perithecia are recent, but the experiments have been repeated a sufficient number of times to make them seem worthy of being recorded here. Cultures of several fungi were barely covered with water and allowed to stand about twenty-four hours. The liquid was filtered through paper and then through a Berkefeld filter, thus avoiding sterilization by heat; for, as already stated, cultures of the various fungi, which in living condition stimulate the production of perithecia, after heating, no longer have this stimulating effect. In some cases the liquid only was used and in others the mat of mycelium was crushed in a mortar, squeezed through cheese cloth and the juice thus obtained also filtered with the extract. There is some indication that the latter method is the better one, but this point has not been fully determined. All the extracts from fresh fungi, so far tried, have been made with water only and sterilized by passing the liquid through a Berkefeld filter. Cultures of *Thielavia basicola* Zopf, No. 1603, were made in the usual way upon pea meal agar and some of the extract, prepared as above described, poured into the tube and allowed to flow over the transplant. In every case the fungus from which the extract was made was also grown upon pea meal agar to avoid conflicting results which might arise from the introduction of some other medium. Check cultures on pea meal agar alone were also made in every series.

Nine different extracts of *Thielaviopsis basicola* (Berk.) Ferraris were made and each one caused a marked stimulation both in growth and perithecial production, in the majority of cases fully equaling in numbers the perithecia formed in mixed cultures of the two living fungi. Following the use of extracts a stimulation in growth is noticeable within a few days, but the formation of perithecia is slower than when two living fungi are cultured together. However, in every series, the checks have no perithecia or only a few scattered ones, while the cultures treated with the extracts have produced them abundantly. The age of the fungus from which the extract is made, amount of water necessary for

extracting and the optimum length of time required for extraction are probable factors which affect the number and rapidity of perithecial development.

Three different extracts were made from *Cladosporium fulvum* and one from *Aspergillus umbrosus*. In all cases these extracts also greatly stimulated growth and perithecial production. As when grown with the living fungi, *Thielavia basicola* produces no asexual spores when treated with any of the extracts so far used.

The effect of heat upon the extracts was tried both in the autoclave at twenty pounds pressure for twenty minutes and by boiling in the open for twenty minutes. Without exception both methods of heating have so far completely destroyed the stimulating power of the extract. Extracts from *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* and *Fusicladium pirinum* have not yet been tried.

As stated above, *Thielaviopsis paradoxa*, in living condition, failed to stimulate the production of perithecia and it was also suggested that the failure with many fungi in living condition might be due to the smothering of the more delicate *Thielavia basicola*. If this is the situation, then, extracts from such luxuriant fungi might act as stimulants even though the living fungus gave no result. While one experiment is not sufficient to be conclusive it may be stated here that an extract made from *Thielaviopsis paradoxa* also greatly stimulated growth and perithecial formation. The case is the same with *Saccharomyces cerevisiae*. Cultures of yeast were made on pea meal agar and mixed cultures were made from them and *Thielavia basicola*. In each case the yeast completely covered the *Thielavia basicola* transplant before it had time to grow; but two different extracts made from fresh yeast cultures, stimulated growth and perithecial production. The stimulating factor in the yeast extract was also completely destroyed by heating.

To determine whether commercial extracts of fungi contained the stimulating factor, 1%, 2%, 4% and 6% water solutions of Taka-diastase were made and filtered through a Berkefeld filter. Cultures of *Thielavia basicola* were treated with these by the same method as with the preceding extracts. The resulting growth far surpassed that following the use of any other extract so far used. The mycelium became very abundant and made almost a felt-like growth. Later, perithecia developed. The type of growth following the addition of Taka-diastase differs so markedly from that in any medium or extract which has been tried that it suggests the presence of two factors, one an unusually potent stimulant for growth and another stimulating perithecial formation. See Plate XXXIX.

The nature of the factors in any of the extracts above considered, causing such a striking increase in growth and production of perithecia of *Thielavia basicola*, is beyond the scope of the problem at hand. The results with the mixed cultures of *Thielavia basicola* Zopf and of other fungi are an indication that this fungus should

not be considered the perfect stage of *Thielaviopsis basicola* (Berk.) Ferraris any more than of the other fungi above noted. The results with extracts, here recorded, are an additional indication that *Thielavia basicola* is a distinct fungus and they are also an argument against any ideas of heterothallism that may have been connected with it.

Thielavia basicola Zopf has always been found associated with *Thielaviopsis basicola* (Berk.) Ferraris on the same hosts. Whether or not it is by itself parasitic on these hosts or, as has been suggested by Dr. Clinton, a parasite on *Thielaviopsis basicola*, is not yet determined. Inoculations of *Thielavia basicola* have been made on tobacco in the greenhouse as well as in the field without definite results. The biologic relationship of these two forms is not yet clear.

Summary.

Perithecia of *Thielavia basicola* Zopf have been secured in artificial culture.

Since the name *Thielavia basicola* was given by Zopf on account of the presence of perithecia, the fungus secured from their ascospores should be considered *Thielavia basicola* Zopf. This is the first report of its isolation in artificial culture.

Thielavia basicola Zopf has a tendency to produce perithecia when grown alone, but this is greatly stimulated when the fungus is grown with *Thielaviopsis basicola* (Berk.) Ferraris with which it is associated in nature.

It has been shown that *Thielavia basicola* Zopf is also stimulated to produce perithecia when it is grown with *Cladosporium fulvum*, *Aspergillus umbrosus*, *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* Mangin, and to a certain extent with *Fusicladium pirinum*.

It has been shown that *Thielavia basicola* Zopf is likewise stimulated to produce perithecia when it is treated with water extracts obtained from *Thielaviopsis basicola* (Berk.) Ferraris, *Cladosporium fulvum*, *Aspergillus umbrosus*, *Thielaviopsis paradoxa*, *Saccharomyces cerevisiae* and also with a water solution of Taka-diastase.

The above evidence indicates that *Thielavia basicola* Zopf is not the ascospore stage of *Thielaviopsis basicola* (Berk.) Ferraris although the two forms are commonly associated.

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Explanation of Plates.

Plate XXXVII.

Fig. 1. Violet plants infected with *Thielaviopsis basicola* (Berk.) Ferraris and *Thielavia basicola* Zopf.

Fig. 2. Part of section of infected violet root. p, perithecia of *Thielavia basicola*.

Fig. 3. Part of section of infected violet root showing sclerotial masses of hyphae and chlamydospores of *Thielaviopsis basicola*. Photographed by Mr. E. M. Stoddard.

Fig. 4. Part of section of infected violet root showing perithecia of *Thielavia basicola*.

Fig. 5. Part of section of infected pea root showing perithecia of *Thielava basicola*. Photographed by Mr. E. M. Stoddard.

Fig. 6. Part of section of infected tobacco root showing perithecia of *Thielavia basicola*. Photographed by Mr. E. M. Stoddard.

Plate XXXVIII.

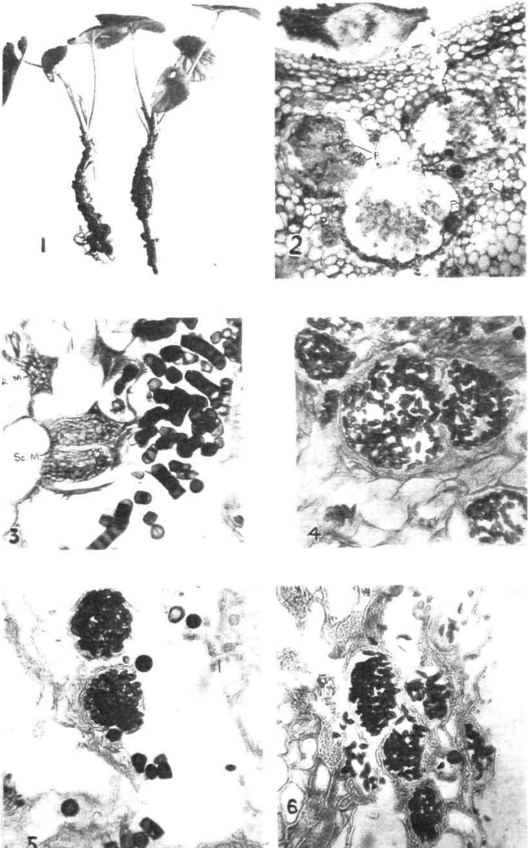
Figs. 1–8. Germination of ascospores of *Thielavia basicola* Zopf. Figs. 1 and 6 magnification x 1,000; Figs. 2–5 and 7-8 mag. x 450.

Figs. 9 and 10. Hyphae of *Thielavia basicola* Zopf. x 600.

Figs. 11–22. Stages in the development of the perithecium of *Thielavia basicola* Zopf. Figs. 11–16, 18, 20–22, magnification x 1200. Figs 17 and 19 mag. x 1,000.

Fig. 23. An ascus of *Thielavia basicola* Zopf with ascospores. x 1,200.

PLATE XXXVII.



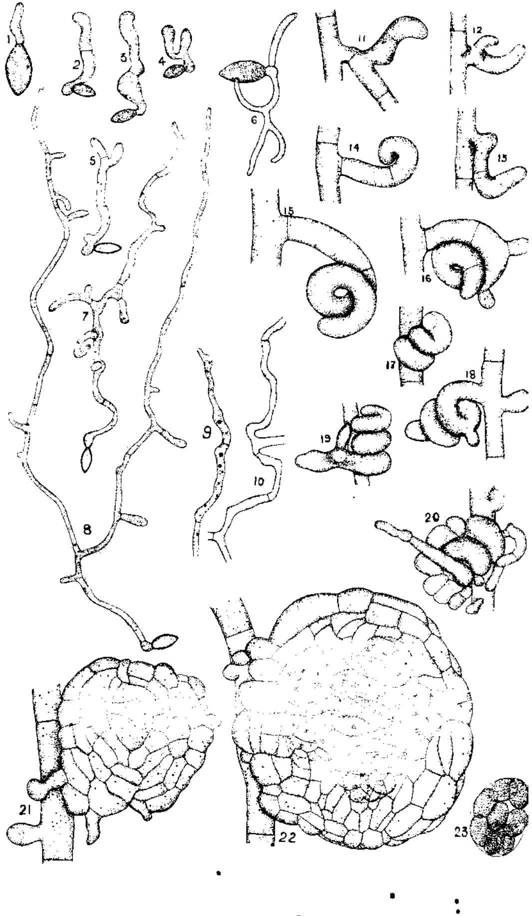

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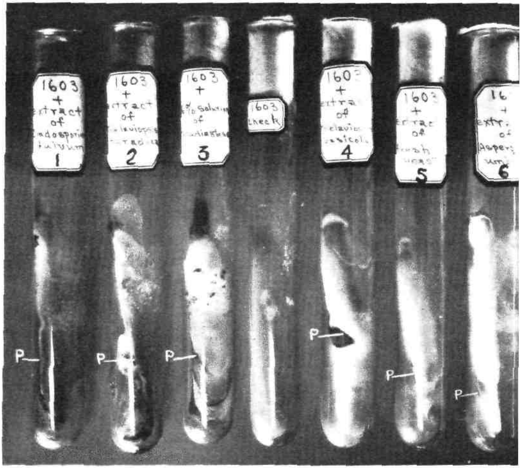
PLATE XXXIX



Cultures of 1603 on pea meal agar. P, perithecia.

No. 1. Addition of a few drops of extract from *Cladosporium fulvum*.

No. 2. Addition of a few drops of extract from *Thielaviopsis paradoxa*.

No. 3. Addition of a few drops of 6% water solution of Taka-diastase.

Check. Pea meal agar alone.

No. 4. Addition of a few drops of extract from *Thielaviopsis basicola* (Berk.) Ferraris.

No. 5. Addition of a few drops of extract from *Saccharomyces Cerevisiae*.

No. 6. Addition of a few drops of extract from *Aspergillus umbrosus*.

Photographed by E. M. STODDARD.

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Tobacco Station Bulletin 5 May, 1925

Connecticut Agricultural Experiment Station
New Haven, Connecticut

Fertilizer Experiments
With
Tobacco

TOBACCO STATION
AT
WINDSOR

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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The Wilson H. Lee Co.

Fertilizer Experiments With Tobacco*

N. T. NELSON and P. J. ANDERSON

Nowhere in the world does tobacco receive so expensive a ration of fertilizer as in New England. About one-third of the entire cost of producing tobacco here is the fertilizer item. Aside from the heavy cost, consideration of the fertilizer problem is extremely important because its composition affects the quality as well as the yield of cigar leaf. Yet, despite its vital importance to the tobacco grower, the investigation of commercial fertilizers for tobacco has received very scant attention from the experiment stations of New England. In the annals of tobacco growing in the Connecticut Valley, extending back for more than a century, there are found records of only two sets of fertilizer experiments. These two classical experiments were conducted thirty years ago at about the same time by Goessmann[1] in Massachusetts and Jenkins[2] in Connecticut. Conditions have changed so much in the last thirty years, both in fertilizers and in tobacco growing, that a considerable part of the conclusions from these experiments may not be applicable to present times. There is need for a reworking of the whole field of commercial fertilizers for tobacco.

There have been numerous fertilizer tests for tobacco in other sections of the country, but the results are of little value to the Connecticut grower because the type of tobacco grown is not the same, the soil and climate are different and the New England system of continuous cropping is different from that followed in other sections.

---

* The fertilizer experiments at the tobacco station at Windsor, were begun in 1922 by Dr. G. H. Chapman, and carried out under his direction until his resignation August 1, 1923. From that time until April 1924, they were continued by C. M. Slagg, and after April 1, by Dr. N. T. Nelson, physiologist in charge. These changes of administration have been unfortunate for the continuity of the experiments and have resulted in considerable loss since the data were recorded in different ways and are not supplemented by actual knowledge of their progress on the part of the present administration.

Since a considerable mass of data has accumulated in the files it has seemed best to publish all of it that is of significance in order to have on record all that has been done. With some modifications and additions the experiments are being continued and it is hoped that the data obtained from them will be published annually in the future. The data on the experiments of 1922 and 1923 are taken entirely from the reports of Dr. Chapman and Mr. Slagg and the present writers wish to give to them all credit for the work done.

[1] Goessmann, C. A. On field experiments with tobacco in Massachusetts. Mass. Agric. Expt. Station. Bulletin **47**:1-31, 1897.

[2] Jenkins, E. H. Experiments in growing tobacco with different fertilizers. Conn. Agric. Expt. Station Report **16**:1-35, **17**:112-114, **18**:254-284, **19**:128-156, **20**:285-333, **21**:230-256 (1892-1897).

Limitations of available space and time to devote to it made it necessary to restrict the experiments at the beginning to an attempt to solve only a few of the problems involved. The experiments were divided into series as follows:

1. *Nitrogen series.* Comparison of different carriers of nitrogen.
2. *Phosphoric acid series.* Comparison of different quantities of phosphoric acid.
3. *Potash series.* Comparison of high grade sulfate of potash with double manure salt.
4. *Manure series.* Comparison of different kinds of manure.
5. *Fractional application series.* Comparison of fertilizer applied all at once with the same amount, or less, divided between several applications.
6. *Sulfur-chlorine-magnesium series.* The purpose of this experiment was to determine the effect of these elements on the tobacco.[1]

In the following pages each of these series is followed separately throughout the three years of the experiment.

NITROGEN SERIES

The tests in this series were designed to answer these questions:

1. *Can all of the nitrogen be furnished to the plant from mineral* carriers,—nitrate of soda, nitrate of potash and sulfate of ammonia?
2. Can one-half of the nitrogen be supplied from these mineral sources, the other half being from cottonseed meal and castor pomace?
3. Can one-half of the nitrogen be supplied to advantage in dry ground fish?
4. Can *one-half of the nitrogen be supplied in tankage?*

The advantage to be sought through the substitution of mineral for the organic sources of nitrogen is reduction in the cost of the fertilizer since the inorganic sources are only about one-half as expensive as the organic sources. In the case of fish, it was hoped also that there might be an improvement in the quality of the leaf. It is the general belief among tobacco growers that the use of inorganic sources of nitrogen produces tobacco of poor quality. In Dr. Jenkins' experiments it was found that where castor pomace was compared with a ration in which one-half of the nitrogen was supplied by pomace and one-half by nitrate of soda,[2] the latter formula did not produce tobacco of as good quality as where castor pomace alone was used, but the yield was increased. In his experiments he also found that the use of fish scrap as the *only* source of *nitrogen reduced the yield but gave a superior quality.* He did not try fish in combination with other sources of nitrogen.

---

[1] This series in cooperation with the Office of Tobacco Investigations, United States Department of Agriculture. Not reported on in this bulletin.

[2] Since the nitrate of soda was applied to the growing crop as a side dressing it is not possible to judge whether the results were due to mineral nitrogen or to fractional application.

The soil in the field on which the tests were made is Hartford sandy loam, and is fairly uniform in texture, drainage and fertility. It was laid out in plots of 1/40 acre, each containing four rows. Only three rows of each plot however, were harvested for the test because the fourth row was on the border and feeding from plots on each side of it treated in different ways. The whole series of seven plots was in triplicate making a total of twenty-one plots. All fertilizers were applied broadcast at one application about one week before setting. Rows were three feet four inches apart and the plants eighteen inches apart in the row. The variety of tobacco was Havana seed and all plots were set on the same day with plants as nearly uniform as could be obtained. The tobacco was primed in 1922 and 1923 but stalk cut in 1924.

After consultation with many growers in the Connecticut Valley and a careful study of previous field experiments, it was decided that a fertilizer containing approximately 260 lbs. ammonia; 225 lbs. phosphoric acid; and 240 lbs. potash to the acre would furnish ample quantities of these plant nutrients for an acre of tobacco. These amounts were considered as a basal ration in this experiment. Although such amounts of plant food materials are greatly in excess of that removed from the soil by the plant, farm practice in the Connecticut Valley has shown that the above quantities grow a good crop of tobacco. Accordingly, all the plots of this series received approximately the same number of pounds of the above plant nutrients per acre.

The fertilizer treatment of the seven plots was as follows:

PLOT N1 BASAL RATION. 1–7 OF THE NITROGEN IN A MINERAL OR INORGANIC FORM (SODIUM NITRATE). THE BALANCE IN COTTONSEED MEAL AND CASTOR POMACE.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	300	.....	115.5	.....
Acid phosphate	200	.....	34.4	.....
Sulfate of potash	400	.....	.....	200.0
Total	4,000	264.2	224.9	239.5

PLOT N2 ONE HALF NITROGEN IN INORGANIC CARRIERS (SODIUM NITRATE AND AMMONIUM SULFATE*). THE BALANCE OF NITROGEN IN ORGANIC CARRIERS (COTTONSEED MEAL AND CASTOR POMACE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,270	104.1	36.9	19.1
Castor pomace	410	27.9	7.4	4.1
Nitrate of soda	365	68.6	.....	.....
Sulfate of ammonia	260	65.0	.....	.....
Precipitated bone	375	.....	144.4	.....
Acid phosphate	213	.....	36.6	.....
Sulfate of potash	433	.....	.....	216.5
Total	3,326	265.6	225.3	239.7

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N3 ALL NITROGEN IN MINERAL CARRIERS (SODIUM NITRATE AND AMMONIUM SULFATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	550	137.5	.....	.....
Nitrate of soda	676	127.1	.....	.....
Precipitated bone	*460*	.....	177.1	.....
Acid phosphate	280	.....	48.2	.....
Sulfate of potash	479	.....	.....	239.5
Total	2,445	264.6	225.3	239.5

PLOT N4 ONE HALF NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE*). THE BALANCE OF NITROGEN IN COTTONSEED MEAL AND CASTOR POMACE.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	*1,270*	*104.1*	*36.9*	*19.1*
Castor pomace	410	27.9	7.4	4.1
Sulfate of ammonia	265	66.3	.....	.....
Nitrate of potash	435	65.3	.....	188.8
Precipitated bone	375	.....	144.4	.....
Acid phosphate	*213*	.....	*36.6*	.....
Sulfate of potash	55.5	.....	.....	27.8
Total	3,023.5	263.6	225.3	239.8

PLOT N5 ALL NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE).

Carrier *Name*	*Lbs. per acre*	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	724	178.0	.....	.....
Nitrate of potash	*552*	82.8	.....	239.6
Precipitated bone	460	.....	177.1	.....
Acid phosphate	280	.....	50.2	.....
Total	2,016	260.8	227.3	239.6

PLOT N6 ONE HALF NITROGEN FROM FISH, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1-7 OF THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	*1,150*	*94.3*	*33.4*	*17.3*
Dry ground fish	1,250	130.5	95.0	.....
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	200	.....	77.0	.....
Acid phosphate	115	.....	19.8	.....
Sulfate of potash	*444*	.....	.....	*222.0*
Total	3,359	262.4	225.2	239.3

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N7 ONE HALF NITROGEN FROM FINE TANKAGE, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1-7 THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,150	94.3	33.4	17.3
Tankage..................	1,359	130.46	108.7	.....
Nitrate of soda...........	200	37.6	.....	.....
Precipitated bone.........	180	.....	69.3	.....
Acid phosphate...........	80	.....	13.8	.....
Sulfate of potash.........	444	.....	.....	222.0
Total................	3,413	262.4	210.7	239.3

From the above figures it is seen that the slight variation in the amounts of ammonia applied to the different plots is negligible. There is, however, a wide difference as to the type of substances used as nitrogen carriers. Plot N1 had one seventh of its nitrogen in mineral form; Plot N2, one half mineral nitrogen; Plot N3, all mineral nitrogen; Plot N4, one half mineral nitrogen; Plot N5, all mineral nitrogen; Plot N6, and Plot N7, one seventh mineral nitrogen. The amounts of potash and phosphoric acid added to the above plots was the same in all cases, approximately 240 pounds K_2O, and 225 pounds P_2O_5 per acre.

SEASON OF 1922

The average yield and quality of the triplicate plots in 1922 as recorded by Chapman is presented in Table I.

TABLE I. EFFECTS OF DIFFERENT SOURCES OF NITROGEN ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Lbs. ammonia per acre Mineral	Organic	Av. yield cured leaf, lbs. per acre	General Quality
N1....	37.6	226.6	1,396	Excellent
N2....	133.6	132.0	1,204	Fair
N3....	264.6	.....	1,456	Poor
N4....	131.6	132.0	1,360	Fairly good
N5....	260.8	.....	1,460	Excellent
N6....	37.6	224.8	1,382	Excellent
N7....	37.6	224.8	1,280	Good

A study of the above table shows that plots treated with all mineral nitrogen fertilizer had a tendency to give greater yields but poorer quality tobacco than plots receiving nitrogen of vegetable or animal origin. The quality of the tobacco on Plots N3 and N5, which received all the nitrogen in a mineral form, was so poor as to warrant an appraisal of fifteen cents a pound less than any other tobacco grown in this series. Not only was the tobacco of the first and second primings very poor, but the fourth was also of little character. The colors especially were poor, running almost entirely to a yellowish red, and not clean. Plots N1 and N6 were of the best quality and had a better finish than any of the

others. The body, grain, texture, and color, were highly satisfactory on these two plots, but plots N3 and N5 produced tobacco of harsh texture, poor color, and too close a grain. Plot N7, on which tankage was used, while yielding a large percentage of desirable colors, gave a more of less dark greenish tobacco after fermentation.

The growth of the tabacco on all of the plots of the nitrogen series was very satisfactory as far as judged by measurements. Topping time showed that there was less than ten percent difference in the average height of plants on the different plots. No fixed growth difference as to height could be attributed to the different fertilizer treatments. Although not suffering in growth, there was one particularly noticeable variation on these plots in 1922. Those plots which were fertilized with a large percentage of nitrogen in the mineral form developed a marked *chlorosis*, apparently directly proportionate to the amount of mineral nitrogen present in the fertilizer. Chlorosis was noticed especially at the base of the plant on those plots supplied with large amounts of mineral nitrogen. On those plots where half the nitrogen was supplied in mineral form and a half from organic sources, chlorotic effects extended upward on the bottom five leaves. Chlorosis extended half way up the plant on the plots which had all the nitrogen applied in mineral form; eight and sometimes ten leaves were affected. This chlorosis was in every respect similar to that called "sand drown" by Dr. W. W. Garner of the United States Department of Agriculture. Immediately adjacent to the nitrogen plots was another series of plots to determine the effects of magnesium deficiency. These plots were specially treated to show the cause of sand drown and were run in cooperation with the United States Department of Agriculture. The chlorosis in the nitrogen plots was in every way similar to the chlorosis which accompanied magnesium starvation on the cooperative plots. For the season of 1922, at least, it was possible that the fertilizers high in mineral nitrogen did not supply adequate amounts of magnesium to fill the deficiency. The plots supplied with an abundance of organic nitrogen, on the other hand, did not develop chlorosis or "sand drown". Organic nitrogen carriers such as cottonseed meal apparently contain magnesium in amounts sufficient to meet the magnesium needs of the tobacco plant on an average Connecticut soil. The season of 1922 was very wet at times, and excessive leaching probably took place (which accentuated the effects). In a drier year, magnesium starvation probably would not follow the application of a heavy mineral nitrogen mixture. No chlorosis was noted in 1923.

Season of 1923.

In 1923 the nitrogen plots were the same as to location and treatment as they were in 1922. It was a much more favorable season, inclined to be dry, while 1922 was extremely wet. The

tobacco was primed. Total weights of the triplicate plots were taken and figured to the acre basis as given in Table II. Each of the four primings was kept separate and a certain number of leaves taken from each for securing sorting data. All data (except total weights) are based on number of leaves. Burn tests were also made. Sorting results are recorded in the table.

In general the results seem inconsistent and no general tendency can be traced. As in the preceding year, the use of all mineral ammoniates resulted in the highest yields. The data on burn and percentage of high grades do not show that the quality was worse than where only one-seventh of the ammonia was from mineral sources. The fact that the burn was always best on the first priming is very apparent. Both dry ground fish and tankage appear to be superior to the basal ration in yield, percentage of higher grades and burn.

Season of 1924.

In 1924 the nitrogen plots were treated in the same manner as in 1923, being set with Havana seed on June 13 and 14, topped August 1 and 2. and harvested August 15 and 16.

Throughout the growing season no significant growth differences were observed between the different plots of the series. The tobacco on Plot N3 was slightly taller than that on the other plots but it also was more mature, being in full bloom when the others were only early and medium bloom at the date of topping. The average number of plants on the plots at harvest (about 160) indicates that the stand was practically uniform throughout the test.

The weather was extremely dry during both the growth and curing periods. The season was too dry for normal growth and a good cure. Scanty "damps" caused some difficulty in getting the crop in proper "case" until late in the fall. The tobacco was taken down in the middle of November and weights in the bundle were made November 28th, 1924.

In February, 1925, the tobacco was sorted by an experienced sorter, Mr. Frank Solkowski, and accurate weights were recorded on the different grades and lengths as indicated in tables III and IV.

TABLE II. SORTING DATA ON NITROGEN PLOTS FOR 1923.

Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
N 1	Basal ration 1–7 ammonia in minerals...........	1,768	564	1	28	....	....	....	70	30–25–24–18
				2	90	....	....	58	....	4– 6–12–10
				3	4	117	10	53	....	7– 6– 7– 9
				4	....	....	134	....	....	3– 5– 4– 3
				Total	122	117	144	111	70	
				%	21.63	20.74	25.54	19.68	12.41	Av. 11 secs.
N 2	½ ammonia in minerals (sulf. am. and nitr. soda)	1,795	535	1	77	....	....	39	35	37–31–28–39
				2	87	....	....	39	....	8–11– 9– 7
				3	49	78		15	....	5– 7– 7– 9
				4	....	6	110	....	....	1– 0– 2– 1
				Total	213	84	110	93	35	
				%	39.81	15.7	20.56	17.38	6.55	Av. 13 secs.
N 3	All ammonia in minerals (sulf. am. and nitr. soda)	1,857	567	1	46	....	....	63	46	20–27–15–33
				2	88	....	....	50	9	7– 6– 6– 5
				3	34	82	....	21	....	3– 5– 7– 9
				4	....	3	125	....	....	1– 0– 1– 2
				Total	168	85	125	134	55	
				%	29.63	14.99	22.05	23.63	9.7	Av. 9 secs.
N 4	½ ammonia in minerals (sulf. am. and nitr. potash).................	1,789	543	1	24	....	....	40	90	67–42–59–53
				2	56	....	....	75	....	25– 7–32– 6
				3	15	90	....	34	....	7–14– 6– 7
				4	....	....	129	....	....	14–10–15–11
				Total	95	90	129	149	90	
				%	17.50	16.58	23.76	27.26	16.57	Av. 23 secs.

SORTING DATA ON NITROGEN PLOTS FOR 1923—*Continued.*

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves: Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	Fire-holding capacity (seconds)
N 5	All ammonia in minerals (sulf. am. and nitr. potash)........	1,955	567	1	30	....	....	70	70	61–83–75–79
				2	81	....	....	52	....	9– 6– 7– 8
				3	20	85	....	40	....	8– 5– 6– 7
				4	....	4	115	....	....	3– 1– 2– 2
				Total	131	89	115	162	70	
				%	23.1	15.69	20.28	28.59	12.34	Av. 22 secs.
N 6	½ ammonia in fish.......	1,927	563	1	69	....	....	56	25	40–45–20–30
				2	82	....	....	50	....	37– 9–30– 7
				3	12	95	10	19	....	3–21–14– 6
				4	....	20	125	....	....	6–14– 7– 6
				Total	163	115	135	125	25	
				%	28.95	20.43	23.98	22.20	4.44	Av. 23 secs.
N 7	½ ammonia in tankage...	1,919	552	1	47	....	....	71	35	45–58–95–63
				2	74	....	....	53	....	13–11–15– 9
				3	30	92	3	20	....	7– 6– 7–13
				4	....	20	107	....	....	6– 3–11– 7
				Total	151	112	110	144	35	
				%	27.35	20.29	19.95	26.08	6.34	Av. 23 secs.

TABLE III. SORTING RESULTS FOR 1924 CROP. TOTAL WEIGHT OF GRADES AND LENGTHS IN OUNCES.

Plot No.	Fillers	Brokes	Tops	Darks				Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
N1	31	63	24	26	63	55	3	5	21	36	15	1	343
N1*	45	122	68	10	34	59	8	0	5	15	17	2	385
N1**	51	68	88	8	45	66	12	5	23	36	14	0	416
N2	44	99	53	8	39	76	18	3	11	27	19	2	399
N2*	46	113	57	14	39	41	9	2	10	23	23	3	377
N2**	45	62	56	13	49	64	6	4	23	48	15	4	389
N3	32	97	36	14	60	89	9	0	11	27	13	0	388
N3*	49	123	117	0	16	31	6	0	3	23	25	3	396
N3**	17	78	86	5	31	67	13	0	10	26	17	0	350
N4	49	75	51	30	65	55	4	3	15	23	10	0	380
N4*	48	106	70	12	53	61	7	3	13	19	3	0	404
N4**	55	76	99	13	53	63	14	2	14	28	10	0	427
N5	44	106	82	20	61	30	2	0	4	9	4	0	362
N5*	32	168	83	4	14	29	7	0	1	8	6	0	352
N5**	50	141	115	3	21	21	1	0	5	9	4	0	370
N6	45	73	45	7	48	77	49	0	4	15	18	7	388
N6*	32	136	47	9	29	48	16	0	5	18	16	2	358
N6**	68	131	51	9	36	28	2	0	11	29	22	7	394
N7	58	149	60	7	35	36	6	0	10	17	23	3	404
N7*	74	127	95	3	14	22	9	0	8	21	32	10	415
N7**	43	113	66	6	33	40	16	0	13	24	19	1	374

In the above table the brokes include poor quality tobacco (better than fillers) such as variegated, mixed, and off colors, also broken leaves and other damaged tobacco.

The tops include short darks, 16" or less, and poor quality long darks. Leaves in the class called darks probably are *not of wrapper quality* but are of heavy body and dark color. No light or medium wrappers were found in sufficient amount to make separate weighings, therefore they are included in the seconds or the darks.

Plot No.	Fillers %	Brokes %	Tops %	% of Darks 18"	20"	22"	24"	% of Lights 16"	18"	20"	22"	24"	Total
N1......	9	18	7	8	18	16	1	2	6	11	4	0	100
N1*.....	11	32	18	3	9	15	2	0	1	4	4	1	100
N1**....	12	16	21	2	11	16	3	1	6	9	3	0	100
Ave. %..	10.7	22.0	15.3	4.3	12.7	15.7	2.0	1.0	4.3	8.0	3.7	.3	100
N2......	11	25	13	2	10	19	4	1	3	7	5	0	100
N2*.....	12	30	15	4	9	11	2	1	3	6	6	1	100
N2**....	11	16	14	3	15	16	1	1	6	12	4	1	100
Ave. %..	11.3	23.7	14.0	3.0	11.4	15.3	2.3	1.0	4.0	8.3	5.0	.7	100
N3......	8	25	9	5	15	23	2	0	3	7	3	0	100
N3*.....	12	31	29	0	4	8	2	0	1	6	6	1	100
N3**....	5	22	25	1	9	19	4	0	3	7	5	0	100
Ave. %..	8.3	26.0	21.0	2.0	9.3	16.7	2.7	0.0	2.3	6.7	4.7	.3	100
N4......	13	20	13	8	17	14	1	1	4	6	3	0	100
N4*.....	12	26	17	3	13	15	2	1	3	5	3	0	100
N4**....	13	18	23	3	12	15	3	1	3	7	2	0	100
Ave. %..	12.7	21.3	17.6	4.7	14.0	14.7	2.0	1.0	3.3	6.0	2.7	0.0	100
N5......	12	29	23	6	17	8	0	0	1	3	1	0	100
N5*.....	11	47	24	1	4	8	2	0	0	2	1	0	100
N5**....	13	38	31	1	6	6	0	0	1	3	1	0	100
Ave. %..	12.0	38.0	26.0	2.7	9.0	7.3	0.7	0	0.7	2.6	1.0	0.0	100
N6......	12	19	12	2	12	20	12	0	1	4	4	2	100
N6*.....	9	38	13	3	8	14	4	0	1	5	4	1	100
N6**....	17	34	13	2	9	7	1	0	3	7	5	2	100
Ave. %..	12.7	30.3	12.7	2.3	9.7	13.6	5.7	0.0	1.7	5.3	4.3	1.7	100
N7......	14	37	15	2	9	9	1	0	3	4	5	1	100
N7*.....	18	30	23	1	3	5	2	0	2	5	8	3	100
N7**....	12	30	18	2	9	11	4	0	3	6	5	0	100
Ave. %..	14.7	32.3	18.7	1.7	7.0	8.3	2.3	0.0	2.7	5.0	6.0	1.3	100

The above results indicate that the use of inorganic compounds (such as ammonium sulfate and nitrates) as the only sources of applied ammonia tends to produce increased percentages of the lower grades of tobacco, included largely in the brokes and the tops. This is accompanied by a decrease in the percentage of the more desirable grades especially the seconds.

During sorting, samples were taken from the darks and the seconds which were pooled March 14, 1925, on the basis of color and general quality by Mr. Walter Edwards, official grader for the Connecticut Valley Tobacco Association. Applying 1923 prices, average prices per pound and per acre were computed. The price per pound of the different grades of tobacco grown on the different plots is given in Table V.

TABLE V. SCHEDULE OF PRICES PER POUND.

Plot	Price per lb. on basis of pooling and 1923 prices								
				Darks			Light seconds		
	Fil.	Tops	Brks.	16–18"	18–20"	20–30"	14–16"	16–18"	18–30"
N1	10	15	20	17	27	42½	30	45	72
N1*	10	15	20	17	27	42½	30	45	72
N1**	10	15	20	17	27	42½	30	45	72
N2	10	15	16	17	27	42½	25	37½	65
N2*	10	15	20	17	27	42½	30	45	72
N2**	10	15	20	17	27	42½	30	45	72
N3	10	15	16	17	27	42½	25	37½	65
N3*	10	15	16	17	27	42½	25	37½	65
N3**	10	15	20	17	27	42½	30	45	72
N4	10	15	16	17	27	42½	25	37½	65
N4*	10	15	20	17	27	42½	30	45	72
N4**	10	15	16	17	27	42½	25	37½	65
N5	10	12	16	15	20	35	25	37½	65
N5*	10	12	16	15	20	35	25	37½	65
N5**	10	12	16	15	20	35	25	37½	65
N6	10	15	20	17	27	42½	30	45	72
N6*	10	15	20	17	27	42½	30	45	72
N6**	10	15	20	17	27	42½	30	45	72
N7	10	15	16	17	27	42½	25	37½	65
N7*	10	15	20	17	27	42½	30	45	72
N7**	10	15	20	17	27	42½	30	45	72

Considering the percentage of the different grades as decimal parts of a pound and applying the pool prices, an average price per pound was figured for each plot. After deducting 11 cents per pound for sorting, sweating, storage and overhead (the Association charge for the 1923 crop) the net return per pound is presented in Table VI.

TABLE VI. SUMMARY OF RESULTS FOR 1924 ON NITROGEN PLOTS.

Plot No.	Treatment	Yield per acre in lbs.	Net price per lb.[1] (cents)	Net value of tobacco per acre	Fert. cost per acre	Net return per acre
N1	1/7 Min. N. (Nitr.	1,307	22.04	$288.06	.....	......
N1*	Soda)	1,387	16.30	226.08	.....	......
N1**		1,493	19.58	292.33	.....	......
Ave.		1,396	19.31	268.82	$94.65	$174.17
N2	½ mineral N.	1,360	18.05	245.48	.....	....
N2*	(Nitr. soda and	1,307	18.10	236.57	.....	......
N2**	amm. sulf.)	1,387	22.43	311.10	.....	......
Ave.		1,351	19.53	264.38	84.65	179.73
N3	All min. N. (Nitr.	1,387	18.31	253.96	.....	......
N3*	soda and amm.	1,440	13.67	196.85	.....	......
N3**	sulf.)	1,387	20.02	277.68	.....	......
Ave.		1,405	17.33	242.83	69.56	173.27
*N4	½ Min. N. (Nitr.	1,333	15.18	203.46	.....	......
N4*	pot. and amm.	1,440	16.56	238.46	.....	......
N4**	sulfate)	1,467	15.26	223.25	.....	......
Ave.		1,413	15.67	221.72	79.37	142.35
*N5	All min. N. (Nitr.	1,280	7.68	98.30	.....	......
N5*	pot. and amm.	1,360	6.90	93.84	.....	......
N5**	sulf.)	1,360	6.53	88.80	.....	......
Ave.		1,333	7.04	93.65	62.15	31.50
N6	½ Nitrogen in D.	1,440	20.63	297.07	.....	......
N6*	Gr. fish	1,413	17.42	246.14	.....	......
N6**		1,360	17.05	231.88	.....	......
Ave.		1,404	18.37	258.36	95.06	163.30
N7	½ Nitrogen in fine	1,413	13.22	186.80	.....	......
N7*	tankage	1,440	16.63	239.47	.....	......
N7**		1,440	21.47	309.17	.....	......
Ave.		1,431	17.11	244.81	86.19	138.62

SUMMARY OF THREE YEARS EXPERIMENTS ON NITROGEN RATION.

In summarizing the results of the first three years of these tests, it must be kept in mind that the experiments are not yet complete and any tentative decisions drawn may be reversed by results of the experiments of 1925 or subsequent years. Also it must be remembered that only one of the three years was a normal tobacco year, viz., 1923. The season of 1922 was unusually wet while 1924 was abnormally dry. It is conceivable that the results in a normal year might be different.

[1] Ave. yield for 3 years.

*—Through a mistake which was not discovered until after the conclusion of these experiments plots N4 and N5 were treated with a low grade nitrate of potash (18% NH_3 and 12.76% K_2O) instead of a high grade (15% NH_3 and 43.4% K_2O) as was considered in working out the formula. The total amount of ammonia added to N4 was 275.6 lbs. and the potash was reduced to 106.5 lbs. per acre. Plot N5 likewise had the ammonia increased to 277.4 lbs. and the K_2O reduced to 70.4. It is quite certain this mistake also occurred in 1923. For this reason, the results obtained on these two plots in 1923 and 1924 are of doubtful significance.

Nevertheless with the preceding reservations in mind, let us see what tentative answer can be made to the questions proposed on page 4.

1. *Can all the nitrogen be supplied from mineral sources?* In answering this question it is best to disregard, for the reason previously stated, the plots on which nitrate of potash was used. Thus the question really is: Can all of the nitrogen be supplied from a mixture of nitrate of soda and sulfate of ammonia? This may be answered by comparing plots N1 (basal ration) with N3 (all nitrogen in sulfate of ammonia and nitrate of soda). The average yield of the N1 plots for the three years was 1,520 lbs. and for N3 was 1,573 lbs., showing thus a small increase in weight of cured leaves. In 1922 the quality of tobacco raised on N3 was rated poor as compared with N1 rated excellent. The sorting records for 1923 do not show that the N3 tobacco was inferior to N1. In 1924 the average price of the N1 tobacco was 2c. per pound higher than N3. When, however, this is balanced against the reduced cost of the fertilizer used on N3, the net return to the grower was only 90c. per acre less than where the more expensive fertilizer was used. However, since the quality was undoubtedly inferior during two out of the three years it would seem best for the grower to avoid the entire substitution of mineral sources of nitrogen and keep up the quality of the tobacco even though the immediate net return is no larger.

2. *Can one half of the nitrogen be supplied from sulfate of ammonia and nitrate of soda?* This question may be answered by comparing the records of the N1 plots with the N2 plots. The average yield on the N2 plots was 70 lbs. per acre less than the N1 plots for the three years. In 1922 the N2 tobacco was rated as "fair in quality" compared with N1 rated "excellent". On the other hand the sorting records of 1923 show somewhat better quality in N2 than in N1. The average price for the 1924 crop was practically the same for N1 and N2. The sorting records indicate about the same quality. The net return for the N2 tobacco was $5.56 per acre greater than for the N1 tobacco in 1924 because of the reduced price of the fertilizer. In answer to the question then we may say that the results during 3 years of tests indicate that mineral carriers of nitrogen may be used to advantage to supply one half of the ammonia.

3. *Can one half of the nitrogen be supplied to advantage in dry ground fish?* This may be answered by comparison of the records of the N1 and the N6 plots. The average yield of the N6 plots for the three years was 1,571 lbs. as compared with 1,520 lbs. for the N1 plots. In 1922 the quality of the two was rated the same. In 1923, N6 had more light wrappers, more seconds, fewer fillers and brokes and much longer fire-holding capacity than N1. In 1924 the average price of the N6 tobacco was about 1 cent less

than N1 and the net return per acre after deducting the cost of the fertilizer was $10.87 less for the fish plots than for the basal ration plots. Since the favorable results of the first two years are contradicted by the third year's results it would seem best to delay a decision until after further tests. At least we can say that the fish ration compared very favorably with the basal and it was superior during two of the three years.

4. *Can one half of the nitrogen be supplied in tankage?* The answer is obtained by comparing the records of plots N7 with N1 during the three years. The average annual yield per acre of the N7 plots was 1,543 as compared with 1,520 for the N1 plots. In quality N7 was rated "good" in 1922 as compared with "excellent" for the N1 plots. The sorting records of 1923 show a higher percentage of light wrappers and seconds, a smaller percentage of fillers and brokes and a better fire-holding capacity on the N7 tobacco than the N1 plots. The situation is just reversed in 1924 when the average price per pound for the tankage tobacco was 2.2 cents less than N1 tobacco and the net return per acre was $35.55 less than where the basal ration was used. Here again, the results of the three years are contradictory and final decision must be reserved until after further trials have been made. The case does not seem quite as favorable for tankage, however, as for the substitution of fish.

PHOSPHORIC ACID SERIES.

This series was begun in 1922 with the object of determining how much phosphoric acid should be used on tobacco. There is considerable difference of opinion on this point among tobacco growers. The only experiments dealing with this point on Connecticut Valley tobacco are those recorded by Jenkins which were conducted in co-operation with the United States Department of Agriculture.* In experiments on shade tobacco they found that by increasing the acre application of phosphoric acid from 210 to 310 pounds, the yield was increased by 25 pounds when precipitated bone was used, 55 pounds with double superphosphate and 88 pounds with acid phosphate. The burn and quality was good on all but best where precipitated bone was used to supply the extra hundred pounds of phosphoric acid. In another test, on broadleaf, they increased the phosphoric acid from 176 to 276 pounds by addition on successive plots of (1) acid phosphate (2) Thomas slag (3) double superphosphate and (4) precipitated bone. The addition of acid phosphate did not increase the yield, slag increased it by 108 lbs. per acre, double superphosphate by 144 lbs. and precipitated bone by 408 lbs. The burn was freer on the plots without added phosphoric acid but the leaf grown on added double super-

* Jenkins, E. H., Studies on the tobacco crop of Connecticut. Conn. Agric. Expt. Station, Bulletin 180:28–30. 1914.

phosphate and on precipitated bone had better quality than the others. From these data one would expect that there would be a distinct advantage in raising the amount of phosphoric acid to about 300 lbs. per acre.

At the Windsor station during 1922, '23 and '24 four plots in triplicate received varying amounts of phosphoric acid according to the following formulas. The amount of ammonia and potash was the same in all. The plots were on the same field as the nitrogen series during these years and all treatment throughout the season after the application of the fertilizer was the same for all plots.

PLOT P1. BASAL RATION 225 LBS. P_2O_5. SAME AS N1.

PLOT P2. BASAL RATION BUT WITHOUT ACID PHOSPHATE OR PRECIPITATED BONE. 75 LBS. P_2O_5.

Carrier Name	Pounds per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	....	....
Sulf. potash........	400	....	....	200.0
Total..........	3,500	264.2	75.0	239.5

PLOT P3. 190.5 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	.....	.....
Precipitated bone...	300	.....	115.5	.....
Sulfate potash......	400	.....	.....	200.0
Total..........	3,800	264.2	190.5	239.5

PLOT P4. 306 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	.....	.....
Precipitated bone...	600	.....	231.0	.....
Sulfate potash......	400	.....	.....	200.0
Total..........	4,100	264.2	306.0	239.5

During 1922 the plots were carefully watched for any signs of earlier maturity. The triplicate plots, P4, almost from the start showed a marked tendency to early ripening and the buds appeared on the plots of this series fully a week before the others. This plot, P4, had received a very high application, 306 lbs., of phosphoric acid per acre. On none of the other plots of this experiment (on which phosphoric acid was applied in amounts ranging from 75–225 lbs. to the acre) was there noted any such tendency to

early maturity. All the tobacco was harvested at the same time in spite of the early maturity of the plants in plots P4. In the following table will be found the amounts of phosphoric acid applied per acre and the resulting yields with Chapman's notes as to quality.

TABLE VII. EFFECTS OF DIFFERENT AMOUNTS OF PHOSPHORIC ACID ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Pounds of P_2O_5 per acre	Yield of cured leaf lbs. per acre	General Quality
P1	225	1,419	Excellent
P2	75	1,425	Good—Greenish
P3	191	1,456	Excellent
P4	306	1,386	Poor—double colors

Within the limits of this experiment, varying the amounts of phosphoric acid had little effect on the yield. Only one treatment, P4 (with an excessively high application of phosphoric acid) showed any appreciable effect and this was on the quality rather than on the yield. The tobacco from P4 was inferior and showed many double colors, probably due to the fact that it was harvested over-ripe. The colors of P2 were inclined to be more green than the other plots but the tobacco was of fine quality otherwise.

In 1923 tests of plots P1–4 and replicates were conducted just as in 1922, the location of the plots and treatment being the same. The unfavorable effect of high application of P_2O_5 was apparently the same as in 1922 but the notes are scanty. The tobacco was primed. Records were taken from sample hands of leaves as in the case of the nitrogen series. Burn tests were made. Table VIII includes all records taken.

These data do not indicate that there has been a reduction in yield from omission of all mineral carriers of P_2O_5. The fire-holding capacity is strikingly best on the plot which received the least P_2O_5. In view of the fact that acid phosphate is believed to be detrimental to the burn of the leaf, it is puzzling to find that P1 which received acid phosphate had a longer fire-holding capacity than P3 or P4 which received no acid phosphate, and that P1 also had the highest yield.

During 1924 no wide differences in growth and maturity were observed. Plot P2 might possibly have been slower and Plot P4 more rapid in developing buds and flowers than the other plots of this series.

The tobacco was taken down, stripped, sorted and weighed at the same time as the nitrogen plots. The sorting results are given in Table IX.

TABLE VIII. SORTING DATA ON PHOSPHORIC ACID PLOTS FOR 1923.

Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
P1	Basal ration, 225 lbs. P_2O_5.	1,919	544	1	30	....	....	50	50	53–61–49–60
				2	107	....	....	35	....	11– 9– 6– 7
				3	25	100	9	9	....	9– 6– 5– 7
				4	....	9	120	....	....	11–14–23–25
				Total	162	109	129	94	50	
				%	29.79	20.03	23.71	17.28	9.19	Av. 22 secs.
P2	Without acid phos. or ppt. bone. 75 lbs. P_2O_5	1,863	547	1	57	....	....	40	51	37–31–29–30
				2	95	....	....	40	....	65–51–67–11
				3	38	91	4	3	....	47–29– 8– 6
				4	....	8	120	....	....	21–16–14–20
				Total	190	99	124	83	51	
				%	34.66	18.15	22.68	15.18	9.33	Av. 30 secs.
P3	190½ lbs. P_2O_5, without acid phos.	1,826	550	1	93	....	....	32	30	40–20–41–33
				2	112	....	....	17	7	8– 5–15–11
				3	70	61	....	12	....	10– 8–13– 9
				4	....	30	85	1	....	16–13–11–14
				Total	275	91	85	62	37	
				%	50.00	16.55	15.46	11.27	6.72	Av. 17 secs.
P4	306 lbs. P_2O_5, without acid phos.	1,853	564	1	54	....	....	47	43	40–35–37–36
				2	116	....	....	28	....	12–20–17–20
				3	31	96	....	13	....	10– 9– 5– 7
				4	....	20	116	....	....	7–10–12–13
				Total	201	116	116	88	43	
				%	35.64	20.57	20.57	15.60	7.62	Av. 18 secs.

TABLE IX. SORTING RESULTS FOR 1924 CROP. PHOSPHORIC ACID PLOTS.

WEIGHT OF LEAVES IN EACH GRADE.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks				Oz. of Light Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
P1.......	43	113	66	12	40	92	38	0	13	24	21	2	464
P1*......	32	114	82	18	32	42	13	2	12	25	24	3	399
P1**.....	26	95	38	17	48	64	2	2	13	34	12	0	351
P2.......	45	128	79	4	29	42	9	0	3	16	18	2	375
P2*......	32	114	47	14	53	72	18	3	13	27	18	0	411
P2**.....	30	81	44	18	66	85	14	3	16	39	19	0	415
P3.......	35	113	56	7	32	76	23	2	8	24	37	5	418
P3*......	35	103	47	8	39	62	17	2	12	30	23	2	380
P3**.....	42	87	38	21	66	64	11	3	14	30	14	0	390
P4.......	40	160	92	5	18	34	10	0	3	13	17	0	392
P4*......	29	113	55	9	49	50	10	5	23	38	23	2	406
P4**.....	29	113	55	16	50	63	8	2	12	29	15	0	392

PERCENTAGE OF EACH GRADE AFTER SORTING

Plot No.	Fillers	Brokes	Tops	Darks 18"	Darks 20"	Darks 22"	Darks 24"	Light Seconds 16"	Light Seconds 18"	Light Seconds 20"	Light Seconds 22"	Light Seconds 24"	Total
P1.......	9	24	14	3	9	20	8	0	3	5	5	0	100
P1*......	8	28	21	5	8	10	3	1	3	6	6	1	100
P1**.....	7	27	11	5	14	18	1	1	4	9	3	0	100
Av. %...	8.0	26.3	15.4	4.3	10.3	16.0	4.0	.7	3.3	6.7	4.7	.3	100
P2.......	12	34	21	1	8	11	2	0	1	4	5	1	100
P2*......	8	28	11	3	13	18	4	1	3	7	4	0	100
P2**.....	7	19	10	4	16	22	3	1	4	9	5	0	100
Av. %...	9.0	27.0	14.0	2.7	12.3	17.0	3.0	.7	2.7	6.6	4.7	.3	100
P3.......	8	27	13	2	8	18	5	1	2	6	9	1	100
P3*......	9	27	13	2	10	16	4	1	3	8	6	1	100
P3**.....	11	22	10	5	17	16	3	1	3	8	3	0	100
Av. %...	9.3	25.3	12.0	3.0	11.8	16.8	4.0	1.0	2.8	7.3	6.0	.7	100
P4.......	10	41	23	2	5	9	2	0	1	3	4	0	100
P4*......	7	28	14	2	12	12	3	1	6	9	6	0	100
P4**.....	7	29	14	4	13	16	2	1	3	7	4	0	100
Av. %...	8.0	32.7	17.0	2.7	10.0	12.3	2.3	.7	3.3	6.3	4.7	0.0	100

Averaging the results given in the above table, the following comparisons can be made as to the effects of P_2O_5 on quality.

TABLE X—SUMMARY OF TABLE IX.

Plots	Pounds P_2O_5 Per Acre	Part Mineral P_2O_5	Fillers Average %	Brokes Average %	Tops Average %	Darks Average %	Seconds Average %
P1	225	2/3	8.0	26.3	15.4	34.6	15.7
P2	75	none	9.0	27.0	14.0	35.0	15.0
P3	191	7/12	9.3	25.3	12.0	35.6	17.8
P4	306	3/4	8.0	32.7	17.0	27.3	15.0

TABLE XI. SCHEDULE OF PRICES PER POUND.

Plot	Price per pound on basis of pooling, using 1923 prices.								
	Filr.	Tops	Brks	Darks			Seconds		
				16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
	¢	¢	¢	¢	¢	¢	¢	¢	¢
P1	10	15	18	17	27	42½	28	40	68
P1*	10	15	18	17	27	42½	28	40	68
P1**	10	15	18	17	27	42½	28	40	68
P2	10	15	20	17	27	42½	30	45	72
P2*	10	15	20	17	27	42½	30	45	72
P2**	10	15	20	17	27	42½	30	45	72
P3	10	15	18	17	27	42½	28	40	68
P3*	10	15	18	17	27	42½	28	40	68
P3**	10	15	20	17	27	42½	30	45	72
P4	10	15	16	17	27	42½	25	37½	65
P4*	10	15	16	17	27	42½	25	37½	65
P4**	10	15	16	17	27	42½	25	37½	65

The above schedule of prices is based on pool ratings by Mr. Walter Edwards and 1923 Pool prices. Average prices per pound of the tobacco grown on the different plots were computed on the same basis as the nitrogen plots. This is given in Table XII.

CONCLUSIONS FROM THREE YEARS DATA ON THE PHOSPHORIC ACID PLOTS

The most striking result of these experiments is the bad effect of increasing the phosphoric acid to 306 lbs. per acre. This is evidenced first by the reduced yield, the average being 31 pounds less than where no mineral phosphoric acid was used. In quality it was rated as "poor" in 1922 as compared with "excellent" for the P1 plot. The sorting data for 1923 show little difference in the tobacco taken from the different plots. In 1924, however, the quality was so poor that it was pooled at an average price of 4 cents per pound less than where no mineral phosphoric acid was added. The net return after deducting the cost of the fertilizer was $77.36 per acre less than where no mineral phosphoric acid was used.

TABLE XII. SUMMARY OF RESULTS FOR 1924 ON PHOSPHORIC ACID PLOTS.

Plot No.	Treatment	Yield per acre lbs. 1924	Yield per acre lbs. Ave. of 3 years	Net price per lb.[1]	Net value of tobacco per acre	Fert. cost	Net return
P1	225 lbs. P_2O_5 (⅔ mineral P_2O_5)..	1,493	....	$19.16	$286.06	......	......
P1*		1,387	....	16.85	233.71	......	......
P1**		1,307	....	18.96	247.81	......	......
Ave.		1,396	1,610	18.32	255.86	$94.65	$161.21
P2	75 lbs. P_2O_5 (no mineral P_2O_5)..	1,413	....	15.66	221.28	......	......
P2*		1,387	....	19.99	277.26	......	......
P2**		1,387	....	22.78	315.96	......	......
Ave.		1,396	1,561	19.48	271.50	85.15	186.35
P3	191 lbs P_2O_5 (7/12 mineral P_2O_5)	1,493	....	22.03	328.91	......	......
P3*		1,360	....	20.11	273.50	......	......
P3**		1,333	....	19.09	244.47	......	......
Ave.		1,395	1,559	20.41	282.29	92.65	189.64
P4	306 lbs. P_2O_5 (¾ mineral P_2O_5)..	1,387	....	11.31	156.87	......	......
P4*		1,333	....	18.49	246.47	......	......
P4**		1,333	....	16.81	224.08	......	......
Ave.		1,351	1,530	15.54	209.14	100.15	108.99

[1] Net price per pound after deducting 11 cents for sorting, packing, sweating and overhead.

These results are not in accord with those presented by Jenkins as discussed above. No explanation of the contradictory results will be attempted until the tests have been carried further.

The highest average yield for the three years was obtained where 225 lbs. of phosphoric acid were supplied by addition of both acid phosphate and precipitated bone to the organic carriers (P1) but the best quality was obtained on P3 where the acid phosphate was omitted but the P_2O_5 brought up to 191 lbs. by addition of precipitated bone. The latter also gave the highest net return per acre of all the phosphoric acid plots in 1924. The effect of omitting all carriers of mineral phosphoric acid was noticeable only by a slight reduction in quality.

Potash Series.

This series of experiments was begun in 1923 and continued through 1924 with three treatments in duplicate on the same field as the nitrogen and phosphoric acid series. The object of the tests was to compare the effect of supplying one half or all of the potash in double sulfate of potash magnesia instead of supplying it all in high grade sulfate of potash. The occurrence of "sand drown" during 1922 in the other plots previously mentioned suggested the advisability of supplying magnesia in the fertilizer ration. Since the cheapest and most convenient carrier of magnesia is the double manure salt, it has been most frequently used as the source of this element in fertilizer mixtures. It seemed advisable therefore to find out what effect its use would have on the yield and quality of the leaf.

Goessman, in the experiments in Massachusetts previously referred to, after three years of testing, sums up his conclusions in regard to it: "Our results with potash magnesia sulfate as main potash sources of a tobacco fertilizer are not encouraging". In rating the ten fertilizer formulas which were tried he places the two which contained double manure salt at the foot.

Jenkins, in the five year experiment at Poquonock, found that the plot treated with double manure salt gave a higher yield than the plots treated with any other carrier of potash. The quality of leaf, however, was not so good and the fire-holding capacity was less than all the rest except high grade sulfate which stood at the foot of the list although the yield was good. Thus he ranks double sulfate above high grade sulfate while Goessman does just the reverse.

In the face of these contradictory experimental results there appeared to be need of further tests. It was decided to compare plots where double manure salt was the only source with those in which high grade sulfate was the source and also with plots where the ration contained a mixture of the two carriers. The fertilizer ration of each of the plots is as follows:

.PLOT K1. ALL K_2O IN SULPHATE.

Carrier	Lbs. Carrier Per Acre	NH3	P_2O_5	K_2O
Cottonseed meal..........	2,100	172.2	60.9	51.5
Castor pomace...........	800	54.4	14.1	8.0
Nitrate of soda...........	200	37.6	....	....
Precipitated bone.........	300	....	115.5	....
Acid phosphate...........	200	....	34.4	....
Sulfate of potash.........	400	....	....	200.0
Total...............	4,000	264.2	224.9	239.5

PLOT K2. ALL K_2O IN DOUBLE SULPHATE OF POTASH MAGNESIA.

Cottonseed meal..........	2,100	172.2	60.9	31.5
Castor pomace...........	800	54.4	14.1	8.0
Nitrate of soda...........	200	37.6	..	....
Precipitated bone.........	300	....	115.5	....
Acid phosphate...........	200	....	34.4	....
Double sulfate...........	800	....	....	208.0
Total...............	4,400	264.2	224.9	247.5

PLOT K3. K_2O DIVIDED BETWEEN SULFATE AND DOUBLE SULFATE.

Cottonseed meal..........	2,100	172.2	60.9	31.5
Castor pomace...........	800	54.4	14.1	8.0
Nitrate of soda...........	200	37.6	....	....
Precipitated bone.........	300	....	115.5	....
Acid phosphate...........	200	....	34.4	....
Sulfate of potash.........	200	....	....	100.0
Double sulfate...........	400	....	....	104.0
Total...............	4,200	264.2	224.9	243.5

No differences in growth during the season of 1923 were noted. Sorting data on the primed leaves as taken by Slagg are recorded in Table XIII.

During the first year of this experiment no appreciable effects were seen on the yield and quality of the tobacco. The percentages of the two top grades of plots K1, K2 and K3 were 48%, 51.4% and 50.3%, respectively.

The experiment was conducted during 1924 in the same manner as in 1923. The tobacco on the K2 plot was somewhat taller than on the other plots. Otherwise no differences in growth were noticed.

The tobacco was harvested, stripped, and sorted at the same time as the nitrogen plots. Table XIV gives the sorting data on the plots.

TABLE XIII. SORTING DATA ON POTASH SERIES.

Experiments of 1923 by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
K1	All K_2O from H. G. sulfate 5.2 lbs. MgO per acre. .	2,056	576	1	57	....	....	70	35	37–34–35–25
				2	74	....	....	74	....	7– 5– 6– 7
				3	38	94	....	....	....	5– 7– 4– 5
				4	....	14	120	....	....	7– 5– 7– 7
				Total	169	108	120	144	35	
				%	29.34	18.75	20.83	25.00	6.08	Av. 13 secs.
K2	All K_2O from Dbl. Sulf. 90.4 lbs. MgO per acre. .	1,966	564	1	79	....	....	56	27	32–36–47–59
				2	76	....	....	61	....	19–30–11–24
				3	18	94	6	14	....	7– 9– 8–11
				4	....	13	110	....	....	
				Total	183	107	116	131	27	
				%	32.42	18.99	20.57	23.23	4.79	*Av. 25 secs.
K3	K_2O divided between the two. 45.2 lbs. MgO per acre.	2,039	568	1	50	....	....	70	33	40–37–16–20
				2	97	....	....	43	....	5– 5– 6– 7
				3	12	107	16	....	....	4– 5– 3– 4
				4	....	20	120	....	....	4– 5– 7– 6
				Total	159	127	136	113	33	
				%	27.99	22.35	23.94	19.92	5.8	Av. 11 secs.

* Data on fire-holding capacity of the fourth priming for some unexplained reason was omitted. If this were recorded it would reduce the average slightly.

TABLE XIV. SORTING RESULTS FOR 1924 CROP ON THE POTASH PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks				Oz. of Light Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
K1......	37	67	25	7	33	70	48	0	8	26	28	3	353
K1*.....	29	60	39	13	43	88	46	3	7	27	31	2	388
K2......	37	102	42	6	28	66	33	0	14	36	42	5	411
K2*.....	47	72	33	8	54	91	33	5	15	38	21	2	419
K3......	37	55	24	9	56	97	45	4	21	50	34	5	437
K3*.....	45	71	38	18	58	63	15	4	17	36	20	3	388

PERCENTAGE OF EACH GRADE AFTER SORTING.

Plot No.	Fillers	Brokes	Tops	Darks 18"	Darks 20"	Darks 22"	Darks 24"	Light Seconds 16"	Light Seconds 18"	Light Seconds 20"	Light Seconds 22"	Light Seconds 24"	Total
K1......	10	19	7	2	10	20	14	0	2	7	8	1	100
K1*.....	7	15	10	3	11	23	12	1	2	7	8	1	100
Av. %...	8.5	17.0	8.5	2.5	10.5	21.5	13.0	.5	2.0	7.0	8.0	1.0	100
K2......	9	25	10	1	7	16	8	0	4	9	10	1	100
K2*.....	11	17	8	2	13	24	8	1	3	9	4	0	100
Av. %...	10.0	21.5	9.0	1.5	10.0	20.0	8.0	.5	3.5	9.0	7.0	.5	100
K3......	8	13	6	2	13	22	10	1	5	11	8	1	100
K3*.....	12	18	10	5	15	16	4	1	4	9	5	1	100
Av. %...	10.0	15.5	8.0	3.5	14.0	19.0	7.0	1.0	4.5	10.0	6.5	1.0	100

No striking differences in quality were noted in the above plots. Samples were taken from these plots and graded in a manner similar to the other fertilizer plots. These pool ratings are given in Table XV.

TABLE XV. SCHEDULE OF PRICES PER POUND.

	Price per pound on basis of pooling and 1923 prices.								
				Darks			Seconds		
Plot	Fllr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
K1	10	15	20	17	27	42½	30	45	72
K1*	10	15	20	17	27	42½	30	45	72
K2	10	15	20	17	27	42½	30	45	72
K2*	10	15	20	17	27	42½	30	45	72
K3	10	15	20	17	27	42½	30	45	72
K3*	10	15	20	17	27	42½	30	45	72

From the pooling data recorded in Table XV, it is apparent that there were no differences in quality between the different plots.

Regarding the percentage of the different grades as decimal parts of a pound and applying the corresponding pool prices, the average price per pound was figured for each plot, as given in Table XVI.

TABLE XVI. SUMMARY OF RESULTS FOR 1924 ON POTASH PLOTS.

Plot No.	Treatment	Yield per acre	Price per lb.[1]	Net value per acre	Fertilizer cost	Net return per acre
K1	Mineral potash	1333	$24.76	$330.00	....	....
K1*	all sulfate	1387	25.28	350.63	....	....
Ave.		1360	25.02	340.32	$94.65	$245.67
K2	Mineral potash	1413	24.86	351.27	....	....
K2*	all double sul-	1413	23.16	367.25	....	....
Ave.	fate.	1413	24.01	359.26	97.85	261.41
K3	Mineral potash	1467	27.70	406.36	....	....
K3*	½ sulfate, ½	1333	21.60	287.93	....	....
Ave.	dbl. sulfate.	1400	24.65	347.15	95.20	250.95

[1] Prices per pound after deducting 11 cents per pound for sorting, sweating, storage and overhead charges.

SUMMARY OF TWO YEARS' COMPARISON OF HIGH GRADE SULFATE WITH DOUBLE SULFATE OF POTASH.

During the two years of this experiment there has been no marked difference in the quality or quantity of the tobacco grown on the different plots. A somewhat larger yield in 1924 on the plots treated with double sulfate is offset by the smaller yield in 1923. Altogether there appears to be little choice between the three treatments. Apparently, if there were occasion to anticipate

that the crop was going to suffer from magnesia hunger the double manure salt could be used to prevent it without serious impairment of the quality or yield of the tobacco. Ordinarily, however, magnesia hunger is not found where reasonably large amounts of organic fertilizers such as cottonseed meal or castor pomace are used. In this case, there would seem to be no advantage in using sulfate of potash magnesia and it has the disadvantage of adding to the bulk of fertilizer and of doubling the quantity of sulphuric acid introduced into the soil. Any conclusions based on experiments of only two years must necessarily be tentative, however.

Fractional Application Series.

This series was started in 1923 and continued during 1924. There was a double object of the tests (1) to see whether there was any increase in yield or quality above that obtained by the single broadcast application when some of the fertilizer was applied later during the growth of the plants and (2) to see whether a smaller amount applied fractionally would produce as good results as a larger amount applied all at once.

The basal mixture as in N1 was used on all plots, the only variation being in the amount and time of application. The treatments were as follows:

Plots H and H*. Total application 3,000 pounds; 1,400 broadcast, 400 in drill at time of setting, 400 after plants started, 400 at second hoeing, and 400 at later cultivation.

Plots I and I*. Total application 2,000 pounds. None of it broadcast, 400 in drill, 800 at first hoeing, 400 at second hoeing, 400 at later cultivation.

Plot J. 3,000 pounds broadcast. This to serve as a check on the above plots and on other plots where 4,000 pounds per acre was applied.

Between 500 and 600 leaves were taken from each plot when harvested and sorted by Slagg in 1923. Data are recorded in Table XVII.

These data show little difference in quality from the three treatments. Three thousand broadcast yielded over 100 pounds more leaf than 3,000 applied fractionally and about 150 lbs. more than 2,000 applied fractionally. There does not appear therefore to be any gain from fractional application as compared with the same amount broadcast and it is questionable whether the reduction in the cost of 2,000 lbs. of fertilizer as compared with 3,000 lbs. would counter-balance the 150 lbs. reduction in yield and the additional cost of labor for later applications.

During the growing season of 1924 it was noted that the growth was not quite so good on the I plots which received only one ton of fertilizer. The tobacco was topped, harvested, stripped and sorted at the same time as that on the nitrogen plots. The sorting records are presented in Table XVIII.

TABLE XVII—FRACTIONAL APPLICATION SERIES OF 1923.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
H, H*	3,000 lbs. fractional......	1,866	531	1	13	....	....	14	84	20–25–10– 5
				2	57	....	....	84	....	5– 6– 9– 7
				3	11	123	....	10	....	3– 4– 5– 4
				4	....	10	125	....	....	4– 5–10– 7
				Total	81	133	125	108	84	
				%	15.26	25.04	23.54	20.34	15.82	Av. 8 secs.
I, I*	2,000 lbs. fractional......	1,827	588	1	21	....	....	60	78	30–25–26–35
				2	90	....	....	51	....	10–16– 6– 5
				3	38	107	....	....	....	4–13– 5– 6
				4	....	18	125	....	....	5– 7– 6–10
				Total	149	125	125	111	78	
				%	25.34	21.26	21.26	18.88	13.26	Av. 13 secs.
J	3,000 lbs. broadcast......	1,974	570	1	10	....	....	78	56	20–23–10–15
				2	100	....	....	34	....	5–10–28–10
				3	....	121	16	10	....	4– 6– 5– 7
				4	....	5	140	....	....	5– 6–11– 5
				Total	110	126	156	122	56	
				%	19.30	22.27	27.36	21.30	9.77	Av. 10 secs.

TABLE XVIII. SORTING RESULTS FOR 1924 CROP. FRACTIONAL APPLICATION PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks 18"	20"	22"	24"	Oz. of Light Seconds 16"	18"	20"	22"	24"	Total
H.......	32	84	29	25	66	53	6	0	15	24	4	0	338
H*......	30	98	36	23	69	65	10	0	18	25	7	0	381
I........	39	122	83	40	60	19	0	3	15	18	2	0	401
I*.......	48	56	49	31	34	6	0	1	7	11	1	0	244
J........	27	70	30	26	60	64	10	3	16	27	14	0	347

PERCENTAGE OF EACH GRADE AFTER SORTING.

Plot No.	Fillers	Brokes	Tops	Darks 18"	20"	22"	24"	Light Seconds 16"	18"	20"	22"	24"	Total
H.......	10	25	9	7	19	16	2	0	4	7	1	0	100
H*......	8	26	9	6	18	17	3	0	5	6	2	0	100
Av. %...	9	25.5	9	6.5	18.5	16.5	2.5	0	4.5	6.7	1.5	0	100
I........	10	30	20	10	15	5	0	1	4	4	1	0	100
I........	20	23	20	13	14	3	0	0	3	4	0	0	100
Av. %...	15	26.5	20	11.5	14.5	4	0	.5	3.5	4	.5	0	100
J........	8	19	9	8	17	18	3	1	5	8	4	0	100

The samples selected during sorting were judged by Mr. Walter Edwards and on the basis of his pooling and prices for 1923 the following schedule of prices per pound for the different grades was fixed.

TABLE XIX. SCHEDULE OF PRICES PER POUND. FRACTIONAL APPLICATION PLOTS.

	Price per pound on basis of pooling and 1923 prices.				Darks			Seconds	
Plot	Filr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
H	10	15	20	17	27	42½	30	45	72
H*	10	15	20	17	27	42½	30	45	72
I	10	12	20	15	20	35	30	45	72
I*	10	15	16	17	27	42½	25	37½	65
J	10	12	20	15	20	35	30	45	72

The average price per pound for each plot based on the above and the net return per acre are given in Table XX.

TABLE XX. SUMMARY OF RESULTS FOR 1924 ON FRACTIONAL APPLICATION PLOTS.

No. Plot	Treatment	1923 yield per acre	Price per lb.*	Net value per acre	Fertilizer cost	Net return per acre
H	3,000 lbs. basal form-	1253	$17.88	$224.04		
H*	ula applied fraction-	1333	18.74	249.80		
Ave.	ally.	1293	18.31	236.92	$71.00	$165.92
I	2,000 lbs. basal form-	1200	10.36	124.32		
I*	ula applied fraction-	1227	8.68	106.50		
Ave.	ally.	1213	9.52	115.41	47.33	68.08
J	3,000 lbs. applied broadcast before setting.	1307	17.82	232.91	71.00	161.91

*Based on sorting percentages, grading by Mr. Walter Edwards, and pool prices for 1923 after deducting 11 cents per pound for sorting, packing, storage, etc.

SUMMARY OF FRACTIONAL APPLICATION SERIES.

The results of two years' tests show that when 3,000 lbs. of fertilizer are applied to the acre, there is no advantage either in quality or yield of the tobacco when the total amount is divided

between a number of applications. When the quantity of fertilizer applied was reduced, there was a reduction in yield and quality which more than counter-balanced the saving in the cost of fertilizer.

In order to see whether there was any profit in reducing the acre application from 4,000 to 3,000 lbs. per acre, we may compare Plot J with plots N1, P1 and K1 all of which received the same mixture as J but 1,000 more pounds of it. After deducting the cost of fertilizer we find that plot J netted a return of $161.91 to the grower in 1924, while plots N1 netted $174.17, plots P1, $161.21 and Plots K2, $245.67. From these figures it is apparent then that there was no gain from cutting down the fertilizer ration, but a strong probability of a loss. In this connection however, it should be kept in mind that the season of 1924 was very dry. A season characterized by more rainfall might show benefit from fractional application.

Manure Series.

Concerning the value of stable manure for tobacco there is a wide difference of opinion among growers and dealers. Many would not use it even if it cost nothing. Probably the majority of farmers believe in using it, however, and would use more if it could be obtained. The ever increasing price of good manure makes it rather essential that we should find out experimentally just what its value is.

In the Massachusetts experiments previously mentioned, Goessman included plots in which manure at the rate of 10 tons per acre was the only fertilizer applied during two years. In his summary he concluded that the results were "encouraging but not sufficient in number to advise detailed discussion". In the Poquonock experiments, Jenkins treated one plot with 10-12 cords of manure per acre for four years and during two of the years added 500 lbs. of Swift-Sure Superphosphate. Although the yield was much below the average he attributed it to lack of a quickly available source of nitrogen and states that "the use of stable manure as an amendment as well as a fertilizer is necessary to get the best results".

An experiment was begun at the Windsor station in 1923 to test the value of manure as a supplement to commercial fertilizers and to compare cow manure with horse manure. Duplicate plots of one fourth of an acre were treated as follows:

M1—Two tons per acre of the basal ration.

M2—Ten tons of horse manure (New York) in addition to two tons of commercial.

M3—Ten tons of cow manure in addition to two tons of commercial.

The tobacco was stalk cut and one row of each plot weighed and sorted to get the data recorded in Table XXI.

TABLE XXI. MANURE SERIES OF 1923.

Plot	Treatment	Yield per acre	Percentage of grades				
			Light Wrapper	Medium Wrapper	Dark Wrapper	Seconds	Fillers and Brokes
M1	Com. Fertilizer	1540	35.05	9.11	19.76	25.77	10.31
M2	Horse Manure	1514	33.99	1.09	21.70	30.20	13.02
M3	Cow Manure	1928	33.04	12.98	27.85	19.21	6.92

These experiments are on too small a scale and preliminary in nature to warrant any conclusions as to the value of the different treatments.

Bulletins

OF

Immediate Information

Numbers 48 to 50

BULLETIN OF IMMEDIATE INFORMATION No. 48 — MARCH 10, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

PRACTICAL LAWN SUGGESTIONS

M. F. Morgan

Practically every family in the state is concerned in the problem of securing and maintaining a beautiful lawn, but even in this favored climate few are developed to their full possibilities. Many persons confine their activities to the use of the lawn mower when absolutely necessary, and success is commensurate with their efforts. But a greater number fall far short of the ideal through misdirected enterprise. Much time, labor and expense is wasted due to lack of understanding of the essential requirements of lawn grasses.

CORRECT SOIL CONDITIONS THE FUNDAMENTAL BASIS FOR LAWN SUCCESS.

No desirable species of lawn grass, regardless of fertilizer treatment, rolling or watering, can be satisfactorily produced on sand or gravel devoid of humus. In the excavating necessary in the construction of cellar or basement, with attendant grading and filling, the area upon which the lawn is to be established is frequently left covered with subsoil material, often a coarse mass of gravel and building debris. A surface soil of at least four inches of as rich a loam as possible is needed. If the soil is not too sandy, a heavy application of manure will transform a comparitively raw subsoil into a moderately productive condition, but in many cases loam must be brought in from elsewhere. If the original top soil is good, one should use proper care in saving it when excavating and grading, to be spread over the surface. It must be borne in mind that best results are obtained upon a well drained, moderately deep, dark colored, mellow loam or fine sandy loam, underlain with a fine sandy loam, or loam subsoil, resting upon gravel or "hardpan," preferably the latter, at least two feet below the surface. Every reasonable effort should be made to approximate this condition.

THREE CLASSES OF LAWN TURF.

The lawn grower must make a choice between three general classes of turf, and all treatment should be consistent with the characteristics of the one of these to be selected.

The Blue Grass—White Clover Lawn. This forms a sod which is all that the average person desires but it presents two main difficulties. It is possible only on a soil well supplied with lime, and under these conditions greater trouble is experienced with weeds such as dandelion and plantain. In all cases where the soil is acid, as is the natural condition almost everywhere in Connecticut, lime or limestone must be applied usually at the rate of 75 lbs. per 1000 sq. ft. of hydrated lime, or 100 lbs. of finely pulverized limestone. If there is any question as to the acidity of the soil, representative samples may be sent to the Soils Department of the Experiment Station for examination. Since the soil for this type of lawn must be kept "sweet," nitrate of soda is the preferable nitrogenous top dressing. An annual spring application of 5 lbs. per 1000 sq. ft. of this material, with the addition of 3 lbs. of muriate of potash, and every two or three years, 10 lbs. of bone meal, is recommended. In midsummer the application of nitrate of soda should be repeated. The fertilizer materials may be mixed with sand or loam to facilitate their distribution and prevent burning.

The Mixed Grass, Acid-Tolerant Lawn. Many grasses, such as red top, Rhode Island bent and red fescue, are not injured by soil acidity, and produce in mixture a dense turf of fine texture and excellent appearance. On an acid soil, less difficulty is experienced from dandelion, plantain and similar weeds. On such a sod lime should *not* be used. In the fertilizer treatment sulfate of ammonia at the rate of 4 lbs. per 1000 sq. ft. should be substituted for the nitrate of soda, and it is probable that it would be well to use acid phosphate (16%) at the rate of 20 lbs. per 1000 sq. ft. instead of the bone meal.

The "Putting Green" Lawn. The enthusiastic lawn grower strives to duplicate the wonderful velvety carpet growth of uniform quality and texture which is to be seen on the putting greens of the best golf courses. Such lawns require special care in establishment to obtain pure stands of a uniform type. Either red fescue or creeping bent (German bent) are adapted to this type of lawn, preferably the latter. Creeping bent may be produced by planting stolons of a pure strain, and thus any difficulty in obtaining seed of uniform type is avoided. It is almost impossible to transform the average lawn into this condition without reseeding. Either creeping bent or red fescue are acid-tolerant, and the use of lime on such lawns is undesirable. Fertilizer treatment as for the previous type of turf is usually satisfactory.

OTHER FERTILIZER MATERIALS FREQUENTLY USED ON LAWNS.

Stable manure, when obtainable in a well rotted, pulverized condition, is an excellent top dressing in fall, winter, or early spring, but the practice of applying fresh manure in the fall, raking off the coarse material in the spring, cannot be recommended. This is almost certain to introduce many weeds into the lawn.

Pulverized sheep manure is a material of fine mechanical condition and free from weed seeds, but is often deficient in strength, and is too expensive for the average householder.

Whenever available, *compost* or *mushroom soil* are excellent for top dressing. However, all the above materials are rapidly becoming more difficult to obtain, and the average person living under urban conditions must look to chemical fertilizers for lawn maintainance.

Mixed fertilizers when composed of suitable materials in correct proportions, are simple and convenient to use. One must ascertain whether the fertilizer has a tendency to increase or decrease soil acidity, owing to the importance of this factor in relationship to the type of lawn to be produced. A fertilizer containing 8% ammonia, 6% available phosphoric acid and 6% potash (8-6-6) or similar analysis, should be a desirable lawn fertilizer, when used at the rate of 15 or 20 lbs. per 1000 sq. ft. as a spring application.

MORE WATER AND LESS WEEDS.

A good lawn should be rolled frequently and kept short through frequent clipping, and whenever possible, liberal watering during dry seasons should be practiced, especially on the sandier types of soil. It must be remembered that 1000 sq. ft. of lawn will transpire at least 300 gallons of water on warm days. Sprinkling should not be practiced during the hottest portions of the day, since much water is thus lost through direct evaporation.

Eternal vigilance is the price of success in the eradication of weeds. Plantain is best removed during July and August by pulling, while in the case of dandelions, frequent deep cuttings with a knife or spade will prove effective. A drop or two of sulfuric acid injected into the crown with the point of an ice pick, will obviate this necessity. Spraying with iron sulfate solution (2 lbs. per gallon of water) or a reliable commercial chemical weed killer, has given good results. At no time should weeds be permitted to go to seed. It will be found helpful to fertilizer and reseed spots made bare by weed removal.

BULLETIN OF IMMEDIATE
INFORMATION NO. 49

JUNE 30, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REGULATIONS FOR CARRYING OUT THE PROVISIONS OF THE LAW CONCERNING CONCENTRATED COMMERCIAL FEEDING STUFFS.

By the authority of Section 6 of the Act Concerning Concentrated Commercial Feeding Stuffs, Chapter 196, Public Acts of 1925, the following regulations have been adopted for carrying out the provisions of the act. The sections cited under each regulation refer to sections of the law wherein the term defined, or the clause interpreted, occurs.

WM. L. SLATE, JR.
Director of the Connecticut Agricultural Experiment Station.

THOMAS HOLT,
Dairy and Food Commissioner.

REGULATION 1. FEEDS NOT CLASSED AS CONCENTRATED COMMERCIAL FEEDING STUFFS.

(Section 1.)

It is held that the law exempts from classification as concentrated commercial feeding stuffs (1) roughages such as hays, straws, corn stover, ensilage and all materials containing over 60 per cent of water; (2) whole grains; (3) meals made from whole grains when not mixed with other materials or with each other; (4) feed ground from whole grains and sold directly from the manufacturer to the consumer; (5) feed ground from materials furnished by the consumer; or (6) feed mixed according to a formula furnished by the consumer, for his own use.

Regulation 2. Method of Labelling.

(Section 2.)

All concentrated commercial feeding stuffs must be labelled either by a statement printed on the bag or upon a properly attached tag; except that in the case of cottonseed meal sold for fertilizer, or of any concentrated feeding stuff sold in bulk, a certificate which shall contain the information otherwise required to appear upon the bag or upon the tag, may be issued by the dealer in lieu thereof.

The use of wire or any metal in affixing tags is prohibited by law.

Regulation 3. Form of Label.

(Section 2.)

The law requires a statement of (1) the net weight of the feed contained in the package; (2) the name, brand or trademark under which the feed is sold; (3) name and address of the manufacturer or importer; (4) the minimum percentages of (a) crude protein and (b) crude fat, and the maximum percentage of (c) crude fiber contained in the feed; and (5) the separate ingredients of which the feed is composed.

While the law requires only a statement of the items enumerated above no objection will be raised to more complete statements of chemical composition.

Regulation 4. Duties of Manufacturers, Jobbers and Dealers with Reference to Registration.

(Section 3.)

The law requires all concentrated commercial feeding stuffs to be registered with the Connecticut Agricultural Experiment Station on or before September 1st, 1925 and annually thereafter.

Manufacturers, jobbers or individuals shipping feeds into Connecticut will be expected to register their brands and pay the necessary fees thereon. Connecticut dealers should assure themselves that the brands they handle are properly registered. In case the manufacturer or jobber outside the State neglects or refuses to register, the dealer who handles such feeds will be held responsible for such registrations and registration fees.

Dealers within the State who mix their own brands are responsible for the registration and proper labelling thereof.

Regulation 5. Concerning Cottonseed Meal.

Cottonseed meal sold as a fertilizer is required to be registered under the terms of the fertilizer law; if sold also as a feeding stuff it is required also to be registered under the provisions of the feed law; if sold exclusively for one or the other of these purposes, it may be registered only under that law which applies.

Regulation 6. Definitions of Terms Used in the Law, and of Other Terms.

Person. The term "person" is accepted as defined in General Statutes, Chapter 128, Section 2448; it imports the singular or the plural as the case demands; and includes corporations, companies, societies and associations.

Importer. The term "importer" is defined in the Act.

Brand. It is held that a distinct brand name, or a distinct analysis, constitutes a distinct brand.

Nitrogen-free-extract. The term "nitrogen-free-extract" when used in a statement of chemical composition is held to mean that constituent group of substances represented by the percentage obtained when the sum of the percentages of moisture, ash, crude protein, crude fiber and crude fat is subtracted from 100 per cent.

Carbohydrates. The term "carbohydrates" is held to mean nitrogen-free-extract plus crude fiber.

Definitions for Feeding Stuffs. The definitions and standards for feeding stuffs as officially adopted from time to time by the Association of Feed Control Officials of the United States are accepted as official in carrying out the provisions of this law.

Regulation 7. Methods of Analysis.

(Section 2.)

The methods of analysis employed shall be those prescribed by the Association of Official Agricultural Chemists, wherever such methods have been adopted for the determinations desired.

REGULATION 8. "STOCK TONICS."

The law does not include those medicated products used as conditioners for stock and poultry, and which consist essentially of substances possessing, or claimed to possess, medicinal or condimental properties.

TEXT OF THE LAW

AN ACT CONCERNING CONCENTRATED COMMERCIAL FEEDING STUFFS.

(Chapter 196, Public Acts of 1925.)

Section 1. The term "concentrated commercial feeding stuffs" within the meaning of this act shall include linseed meals, cottonseed meals, pea meals, bean meals, cocoanut meals, gluten meals, gluten feeds, dried brewers' grains, dried distillers' grains, malt sprouts, dried beet pulp, hominy feeds, cerealine feeds, rice meals, alfalfa meals, oat feeds, corn and oat chop, corn and oat feeds, scratch feeds, digestor tankage, ground meat scraps, ground fish scraps, mixed feeds, provenders, bran, middlings and mixed feeds made wholly or in part from wheat, rye or buckwheat, and all materials of a similar nature intended for the feeding of domestic animals, including poultry; but shall not include hays, straws, corn stover, ensilage, whole grains or the unmixed meals made directly from the whole grains of wheat, rye, barley, oats, Indian corn, broom corn, rice, buckwheat and flaxseed, or feed ground from whole grain and sold directly from the manufacturer to the consumer.

Sec. 2. Each lot or parcel of concentrated commercial feeding stuffs sold, offered or exposed for sale shall have conspicuously affixed thereto a plainly printed statement certifying (1) the number of net pounds of feeding stuff contained therein, (2) the name, brand or trademark under which the article is sold, (3) the name and address of the manufacturer or importer, (4) a statement of the minimum percentages of (a) crude protein, and (b) crude fat, and (c) the maximum percentage of crude fiber contained in the feeding stuff, all constituents to be determined by the methods adopted by the Association of Official Agricultural Chemists of the United States and in force at the time, and, (5) in the case of feeds composed of two or more ingredients, the name of each ingredient contained therein; provided such statement shall not be affixed by wire or other metallic device, and provided, in the case of cottonseed meal which shall be sold for fertilizer or in the case of any concentrated feeding stuff sold in bulk, the dealer may issue, in lieu of the printed statement herein described, a certificate which shall contain the information required by this section.

Sec. 3. Before any concentrated commercial feeding stuff shall be sold or offered or exposed for sale in this state the person who shall cause it to be sold or offered or exposed for sale shall file with the Connecticut Agricultural Experiment Station, on or before September 1, 1925, and annually thereafter, two certified copies of the statement prescribed in section two of this act, on forms supplied by the Connecticut Agricultural Experiment Station, and shall pay a registration fee of fifteen dollars for each brand to be sold or offered or exposed for sale in this state. When any feeding stuff shall have been registered and the fee paid thereon, the director of said station shall issue a certificate of registration for such feed, and a list of the brands so registered shall be published annually in the station report. Fees so paid to said station shall be used toward defraying the expense of inspection. Whenever registration and payment as prescribed herein shall have been made on any brand of feeding stuff by any person, no other person shall be required to register such brand or to pay a registration fee thereon. The director may refuse registration of any feeding stuff, or may cancel any registration which shall have been made, if it shall appear or shall be found that all the provisions of this act have not been fulfilled, or if the feeding stuff shall bear any statement, design or device which shall be false or misleading as regard to materials of which it is composed. No feeding stuff on which registration shall have been refused or cancelled shall be permitted to be sold or offered or exposed for sale in this state.

Sec. 4. Every manufacturer, importer, agent or person selling or offering or exposing for sale any concentrated commercial feeding stuff in relation to which all the provisions of sections two and three of this act shall not have been complied with, shall be fined not more than one hundred dollars for the first offense and not more than two hundred dollars each subsequent offense.

Sec. 5. The Connecticut Agricultural Experiment Station may collect a sample, not exceeding two pounds in weight, for analysis, from any lot, parcel or package of concentrated commercial feeding stuff or unmixed meals, brans or middlings, which may be in the possession of any manufacturer, importer, agent or dealer, but such sample shall be taken in the presence of the parties in interest or their representatives, and taken from a number of parcels or packages which shall not be less than five per centum of the whole lot inspected, and shall be thoroughly mixed, divided into two samples, placed in glass vessels or other suitable containers, carefully sealed and a label placed on each stating the name or brand of the feeding stuff or material sampled, the name of the party from whose stock the sample was taken and the time and place of taking the same. Such label shall be signed by the station chemist or his deputy and one of such samples shall be retained by such chemist or his deputy and the other by the party whose stock shall have been sampled. Said station shall cause at least one sample of each brand of feeding stuff so collected

to be analyzed annually by or under the direction of such chemist. Such analysis shall include a determination of crude fat, crude protein and crude fiber and any such other determination as may be advisable. Said station shall cause the analysis so made to be published in station bulletins, together with such additional information in relation to the character, composition and use thereof as may be of importance and shall issue the same annually or more frequently if advisable.

Sec. 6. The dairy and food commissioner and the director of the Connecticut Agricultural Experiment Station may make rules and regulations for carrying out the provisions of this act.

Sec. 7. The dairy and food commissioner shall enforce the provisions of this act and when evidence shall be submitted by the Connecticut Agricultural Experimental Station that any provision of this act shall have been violated, he shall make complaint to the prosecuting officer having jurisdiction thereof.

Sec. 8. The term "importer" shall include such persons as shall bring into or offer for sale within this state concentrated commercial feeding stuffs manufactured without this state.

Sec. 9. Sections 4774, 4775, 4777, 4778, 4779, 4780 and 4781 of the general statutes are repealed.

BULLETIN OF IMMEDIATE
INFORMATION No. 50

JULY 15, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REGULATIONS CONCERNING THE SHIPMENT OF NURSERY STOCK, AND THE NEW LAW

W. E. BRITTON, State Entomologist.

NURSERY CERTIFICATES.

The original certificate issued by the State Entomologist under Chapter 265, Public Acts of 1925, is to be kept in the nurseryman's possession, and is not to be attached to any package of nursery stock. It applies to the whole nursery which has been inspected and to such purchased stock as has been received from other nurseries under the certificate of a state or government officer. If any stock is received from outside the state unaccompanied by such a certificate, the State Entomologist should be notified at once so that it may be inspected.

An exact transcript of the certificate including number and date may be printed on labels or tags for shipping and must be attached to each package sent out of the nursery. An additional statement, made by the owner, that the stock has been fumigated will be required in many states. The law now requires that the inspection certificate be attached to every package shipped to points both within the State of Connecticut and outside. Please see that a copy always accompanies each sale whether shipped by freight, express, mail, automobile or whether carried away by the purchaser.

After the date of expiration, which is a part of each certificate, the document becomes invalid and should not be attached to any box, bale or package. The nurseryman has no right to change the date or any other portion of the certificate.

The improper use or abuse of a certificate will not be tolerated, and the certificate may be revoked for cause.

Duplicate copies of certificates for filing in other states will be furnished on request of the nurseryman.

DEALER'S PERMITS.

The original permit issued by the State Entomologist under Chapter 265, Public Acts of 1925, should be kept in the dealer's possession and is not to be attached to any package or shipment of nursery stock, though copies may be made for this purpose.

These may be typewritten or printed and a copy must go with each separate sale from stores, and with each shipment or package of nursery stock transported. This copy must be an exact transcript, and must include number, date of issue and of expiration. After the expiration date, the permit becomes invalid and should not be used. The dealer has no right to alter the date or any other portion of the permit. This permit may be revoked for improper use or abuse, and for not complying with the law.

Shipper's Permits.

The shipper's permit is issued to nurserymen in other states who file applications and duplicate signed copies of their state inspection certificates. The original permit should be kept, and a copy (typed or printed) together with a copy of the inspection certificate of the state in which the nursery is situated should accompany each shipment into Connecticut.

Package Certificates.

Occasionally individuals and firms not in the nursery business wish to ship a few trees or shrubs hut cannot do so without inspection certificates. If such materials can be inspected by our men on their usual trips without extra travel and expense, this will be done on request, as an accommodation. Other inspections may be arranged by special appointment, or plants can be sent to the Station with address and postage for forwarding, and here they will be examined and sent along.

The U. S. Postal Laws and Regulations, Section 467, paragraph 2, governs the mailing of plants and plant products, and reads as follows:

"Nursery stock, including all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable and flower seeds, bedding plants and other herbaceous plants, bulbs and roots, may be admitted to the mails only when accompanied with a certificate from a State or Government inspector to the effect that the nursery or premises from which such nursery stock is shipped has been inspected within a year and found free from injurious insects, and plant diseases, and the parcel containing such nursery stock is plainly marked to show the nature of the contents and the name and address of the sender."

Such materials may be mailed without certificate to any Agricultural Experiment Station or to the United States Department of Agriculture. Florists' plants (not woody, field-grown) and vegetable or other annual herbaceous plants do not require certificates but must be plainly marked as to contents, origin and destination. Package certificates apply only to the contents of the packages on which they are placed, and the contents of which have been examined.

QUARANTINES.

Both state and Federal quarantines prohibit the movement of nursery stock and forest products from the area quarantined on account of gipsy and brown-tail moths to any point outside of that area, without inspection and certificate. Federal Inspectors will be stationed at convenient points to cover the quarantined area of the state. Applications for such inspections may be made to the nearest Federal Inspector or to the following:

Mr. D. M. Rogers, 408 Atlantic Avenue, Boston, Mass.
In charge of Federal gipsy moth quarantine inspection service.

Dr. W. E. Britton, State Entomologist, Agr. Exp. Sta., New Haven, Conn.
In charge of state gipsy moth quarantine inspection service.

THE NEW LAW PROVIDING FOR THE REGISTRATION AND INSPECTION OF NURSERIES

CHAPTER 265, PUBLIC ACTS OF 1925.

SECTION 1. Inspection and Shipment of Nursery Stock: The state entomologist or his deputies or assistants, shall, upon application, inspect at least once each year all nurseries at which woody field-grown trees and plants shall be grown for sale or shipment; may inspect any nursery stock when dug, before shipment or at destination; may inspect nurseries at any time for the purpose of controlling plant pests or to ascertain whether such pests exist in nurseries; may employ such deputies or assistants as he may deem necessary; may prescribe forms for registration, certificates and permits and may make rules and regulations regarding time and methods of inspection; may destroy or treat or order the destruction or treatment of, and prohibit the movement of, plants infested with dangerous pests; may co-operate with agents of the United States Department of Agriculture in the inspection of nurseries and control of plant pests; may, at reasonable times, enter any public or private grounds in performance of his duties under the provisions of this act. In case orders shall be issued for the destruction or treatment of infested plants, the owner, manager or agent of the nursery shall, within a reasonable time from the date of such order, destroy such plants as shall be ordered destroyed and make such treatment within the time specified in the order, or be subject to the penalty provided in section five of this act.

SEC. 2. All nurserymen shall register with the state entomologist each year, on or before July first, and make application for inspection, and furnish such data on such blanks as the state entomologist shall prescribe and furnish. In case a nurseryman shall fail to make such application on or before July first, he shall pay to the state entomologist the cost of such inspection. All firms, stores and individuals who shall sell but shall not grow nursery stock, shall be classed as dealers, and shall, each year, on or before March first, register with the state entomologist, giving the chief sources of their nursery stock and such data as he may require, on such forms as he may prescribe and furnish, and the state entomologist may issue a permit allowing such dealer to sell such nursery stock. Each nursery outside the state, before shipping nursery stock into the state, shall file with the state entomologist a copy of a valid inspection certificate and the state entomologist may issue a permit allowing such nursery to

ship stock into the state. The state entomologist shall keep a record of all money received as costs for inspection, and such money shall be deposited with the state treasurer.

SEC. 3. The state entomologist shall issue to regular nurseries certificates, valid until the first day of August following the date of issue and covering the stock inspected and such other stock as shall have been received under valid certificates of inspection; may issue temporary permits covering certain portions thereof, and permits to dealers. All such certificates and permits may be revoked for cause. Nursery stock which shall not have been inspected or stock from a nursery not holding a valid certificate of inspection shall not be sold or transported, and transportation companies shall refuse to accept any shipment not bearing such certificate or some form of permit issued by the state entomologist, and all nurserymen shall furnish a certificate, and all dealers a permit, to accompany each package of stock sold or transported, but no provision of this act shall prevent or render liable any individual or firm who shall transport stock from his field or property to another field or property belonging to or operated by him, when such stock is not to be immediately sold or offered for sale and when such transportation shall not violate any established federal or state embargo or quarantine regulations.

SEC. 4. For the purposes of this act, any place at which hardy trees, shrubs and vines shall be propagated or grown out of doors for commercial purposes, shall be considered a nursery, and such stock shall be regarded as nursery stock; hardy herbaceous perennial plants, including strawberry plants, may be subject to the same provisions regarding inspection and pest control, if, in the opinion of said state entomologist, it shall seem desirable to control the movement of such plants. Florists' ordinary plants, unless woody and field-grown, shall not be included.

SEC. 5. Any person who shall interfere with the state entomologist or his deputy or assistant in the performance of his duties under the provisions of this act, or any person, firm or corporation who shall violate any of the provisions hereof, shall be fined not more than fifty dollars. Any person aggrieved by any order issued under the provisions of this act may appeal to the superior court, or to any judge thereof if said court shall not be in session, and said court or such judge may grant such relief or issue such order or judgment in the premises as to equity may appertain.

SEC. 6. Section 2119 of the general statutes is repealed.

Approved June 24, 1925.

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